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The Success of Young Children in Number and Letter Construction

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TO TRACE the entire course of children's progress in learning to make numbers and letters would necessitate observation of the child from the time he makes his first random scribbles. For all practical purposes satisfactory data are obtainable from objective samplings of children's efforts to write taken at the age of four or five. The data represent an attempt to measure objectively the success of young children in their early efforts in making numbers and letters. Cumulative objective records of this kind are necessary for the determination of the nature of such learning and provide the only reliable basis for educational procedure with respect to it.

The ability to draw successfully from memory, or to copy letters or numbers depends upon maturity of two kinds, visual-perceptual capacity and motor coördination. Lack of adequate visual-perceptual maturity for copying designs successfully is illustrated in the case of the child who in attempting to copy the Diamond of the Binet test remarks during his struggles that he must "put the ears on." Suiting the action to the word, the resulting diamond, instead of having four straight sides, has several little excursions or projections that "spoil" his work according to the test standards. The child who has adequate visual-perceptive maturity for his task, but lacks sufficient motor control to execute it is illustrated in the not uncommon case of the child who can match designs or geometrical forms, but is unable because of inadequate motor control to produce more than a semblance of the original design which he is asked to copy.

DESCRIPTION OF THE TEST AND PROCEDURE

An objective test of six parts was constructed for the experiment. The materials were prepared in the form of a mimeographed booklet 6 by 8 inches in size, containing on the first page the following five geometrical forms to be copied:

This exercise was designed as a familiarizing and "warming up" device before the main part of the test was given. The results of the fore-exercise subsequently justified their inclusion in the tabulations of results. Page two consisted of blank squares containing identifying figures in each corner in which pupils were directed to write

the following numbers which the examiner dictated:

2 3 4 5 6 7 8 9 54 36 19 87 21

Children who experienced difficulty with this task were encouraged to do their best and to make an effort, even though they had never done anything of the kind before. Page three contained the following numbers opposite which ample space was provided for the child to copy the numbers:

6 3 9 5 7 8 4 2 15 43 109 276

On page four there were two columns of pictures of separate objects opposite which the child was directed to make a designated letter of the alphabet. Although the first letter of the name of each object corresponded with the letter to be written, this relationship was seldom pointed out except in the examination of older children who occasionally detected it themselves, for there was no necessity in the children's recognizing the relationship. The letters to be written were:

B R D E C M G K N P S H

The fifth page contained these letters arranged in two rows which the children were directed to copy. The last page contained a vertical row of the following words which the pupils were also directed to copy in the space adjacent to each word:

he at no dug bat was how

Since the children examined were wholly unable to spell, no attempt was made in this test to dictate the material before it was copied.

Four groups of children were given the test three times at intervals of approximately nine months. All of the children were attending the four or five year kindergarten groups or the first grade of the Lincoln School of Teachers College. At the time of the initial test the median ages of the four groups were respectively 4–5, 5–5, 6–5, and 6–6. Median intelligence quotients as established by the Binet Simon tests averaged 123, 126, 117, and 122, for the four groups. It may be objected that experimentation with such mentally superior subjects invalidates the findings for generalization concerning the progress of average children. Data for average children with the same material are lacking and until they are obtained the objection may be sustained. However, all children, bright, average or dull, start with zero ability in the present task and although the rate of progress may be faster in brighter subjects, the assumption may be made that all children pass through similar stages in acquiring mastery of number and letter construction, types of errors made are common and typical and almost complete perfection in the accomplishment is achieved in early school years, for the ability to make numbers and letters as a mechanical task has proved to be well within the capacity of all but the potentially feebleminded.

For the most part the test was given to pupils in their ordinary classroom groupings except in the case of the four year group who were taken aside in groups of three and four. Maximum effort was sought in order to get adequate information concerning types of errors made in early stages of learning.

Every effort was made to avoid giving the impression that the test was a teaching device or that the test represented good teaching practice. Progressive schools prefer to delay the teaching of writing until some significance can be attached by the child to the performance. In the present experiment this princple was purposely violated but with no ill-results to the children for the test was entered into in the spirit of a drawing game.

During the first period of the experiment there was no classroom instruction of four and five year old pupils in making numbers and letters. Only one of the first grade groups had writing instruction during the early course of the experiment, and this instruction was largely informal and based on pupil needs. During the second period of the experiment the first grade pupils had advanced to second grade where they were given practice in manuscript writing and in making numbers, but the five year group who had advanced to first grade were given only a limited amount of formal instruction. Just before the final test three pupils in one group were absent, but data for these three pupils were retained in the compuation of results for the first two tests. Reading instruction like handwriting was scarcely a factor in the early learning of the four and five year groups and one of the first grade groups. In the other first grade group reading instruction was begun informally but given regularly shortly after the school year was begun. The extent to which parental and home instruction accounts for success on the test is impossible to determine. Judging from remarks of parents and pupils, practically no children in the experimental groups had received regular or formal outside instruction. A parent's most frequent remark on hearing that the children had been given writing tests was to the effect that they had discouraged the children from writing, or that they had given instruction only when the children demanded it or showed unusual interest in it. A few parents were apologetic that they had neglected to give the children such instruction to prepare them for school work. Practice effect from the test was unquestionably present, but uniform throughout the experiment.

In scoring the papers one credit was allowed for each item correct, with a possible total score of 61 for a perfect paper. Uniform standards of scoring the construction of numbers and letters were adhered to in evaluating each item. Separate tabulations were made of the number of items correct, the number wrong, those partly right, items reversed and upside down, and items omitted. Items consisting of two or more digits or letters were scored solely for reversals, that is numbers of letters written inversely in a lateral direction or turned over. If the essential form of the number or letter was correct no deduction was made for accidental variations or irregularities due to poor motor control.

There are possibilities in the present data for answers to a number of interesting and important questions: What is the nature of the improvement curve? Of individual differences in accomplishing the same task for pupils of the same age or grade level? Which

items can be executed successfully at different age levels? To what extent do pupils make reversals in constructing number and letters in the early stages of learning? What is the quality of response at different ages as maturity increases? What is the nature and extent of other types of errors? What is the relation of handedness to the tendency to make reversals? What is the relation of success on the test to success in reading as measured by standardized tests? What is the relation between success in copying symbols and in attempting to make them from memory? Are sex differences in the present task discernible? Is there any relation between ability in number and letter construction and intelligence as measured by standardized tests? What is the consistency of errors on retests? What is the relation of school practice or training in the task and success in it as measured by the present test? Do any of the numbers or letters included in the test appear to be inherently more difficult to make than others? The data obtained during the experiment are sufficient to furnish at least partial answers to all the questions raised.

There are always chance errors to contend with in connection with any test and especially is this true in testing young children who are not always at the maximum of attention, and who are only with difficulty motivated to take tests. The broken crayon, the negavistic attitude, the tendency to ask for help and to expect it, disturbances of external and internal origin are sources of error affecting the data. The general tendency of such errors is to reduce maximum possibilities of accomplishment. In the main the testing conditions and the coöperation of the subjects were rated as excellent. Ideally perfect conditions are scarcely obtainable with pupils of this age.

RESULTS

Spearman makes the statement that all knowing comes from obscurity to clearness and that the process occupies a period of time. Nowhere is this principle better illustrated than in the present experiment. During the period between the ages of approximately four and seven the subjects of the experiment progressed from a stage of learning that was vague, confused, incoherent, to a stage of maximum clarity and ease of accomplishment. The excessive squirming and superfluous large muscle movements, the indecision, failure, enormous struggle and discouragement of the youngest pupils had disappeared at the time of the end test with the older pupils and had given place to orderly workmanship with ease of accomplishment in which superfluous movements had been reduced to a minimum, in which the child clearly showed in his total behavior his familiarity with the task, his success with it, and his delight in it. The difference between the children at the beginning and at the end of the learning period was so great as to constitute almost a complete transformation in attitude and capacity to achieve. The most frequent comment of the youngest children at the beginning of the experiment was "I can't do it. It's too hard. I don't know how. I've never done it;" of the older children "This is too easy—is this

all we have to do today?" The indecision of the younger children was shown in their hesitancy in proceeding with the task, in looking at the examiner for clues and suggestions, in actual requests for information as to how the symbols should be constructed. They very often made erasures, asked permission to do so or asked whether they should do so, and as often as not converted a correct item into an incorrect one. Children were frequently puzzled by the lateral

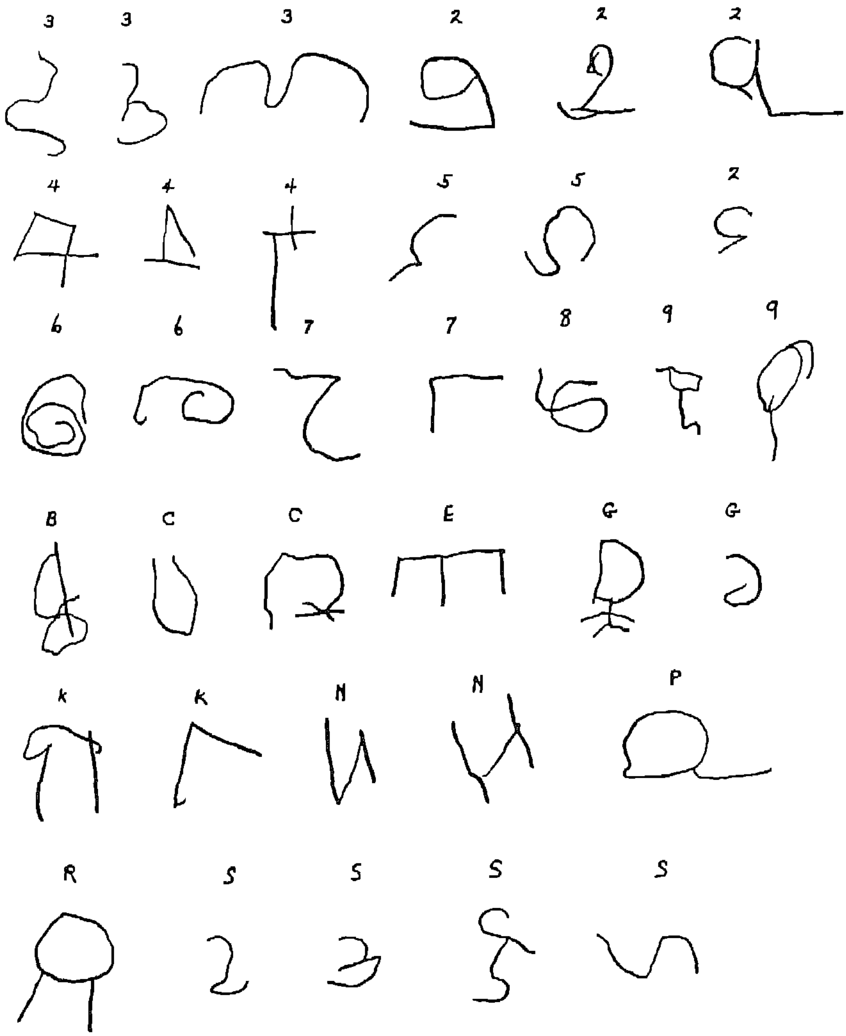

FIG. 1. ILLUSTRATIONS OF TYPICAL ERRORS MADE BY FIVE YEAR OLD PUPILS

direction of letters and numbers, and often asked, "Which way shall I make it?" On receiving no help they commented, "I'll just make it any old way," and in a great number of such

instances a reversal of the symbol was made.

There was not only enormous improvement in attitude but in the quality of workmanship, which can scarcely be indicated in a statistical report of the number of items correct. At the beginning of the experimental period many of the children's copies of letters or numbers were extremely ridiculous, too large, too small, poorly proportioned, irregular, incomplete, or containing superfluous dots and dashes. Fig. 1 shows samples of typical errors made by five year old pupils. The material is not a facsimile reproduction of the pupils' writing but was traced in ink from the pupils' original work in crayon.

At the end of the learning period all was orderly and regular. In many cases the children's copies were fully equal in quality to the sample in the test paper. There was no time limit for the test and no effort was made to record the time required by individual pupils or classes for the successful completion of the test, but general observation of the younger and older children at work indicated very slow work at the beginning of the experiment and almost maximum speed with the older pupils.

TABLE 1

Percentage of responses

TEST	NUMBER OF CASES	CORRECT	WRONG	PARTLY RIGHT	REVERSALS	UPSIDE DOWN	OMITTED
			Kindergarten 4				
1st	21	.235	.323	.076	.058	.028	.277
2nd	21	.56	.166	.022	.081	.013	.155
3rd	21	.743	.048	.028	.076	.004	.101
			Kindergarten 5				
1st	16	.643	.037	.046	.097	.01	.104
2nd	16	.748	.039	.021	.134	.006	.049
3rd	16	.930	.005	.016	.045	.000	.003
			Grade 1[1]				
1st	20	.804	.028	.025	.064	.003	.07
2nd	20	.875	.031	.012	.015	.004	.025
3rd	20	.967	.002	.002	.011	.001	.007
			Grade 1[2]				
1st	21	.899	.007	.01	.056	.001	.024
2nd	21	.906	.014	.007	.055	.003	.014
3rd	18	.997	.001	.001	.001	.000	.000

Quantitative results

Table 1 indicates the percentage of responses that were correct, wrong, right, reversed, upside down and omit-

ted for all groups of children examined on the first, second and third tests. Fig. 2 shows in graphic form the percentage correct for all groups on all tests.

The results indicate continual and gradual rise from low to high percentages of items correct and simultaneously gradual decrease in items wrong, part right, upside down or omitted. Throughout the test, items scored as part right or upside down constitute a negligible proportion of the total number of items. Except for the four and five year kindergarten groups on the first test the number of omissions is also negligible.

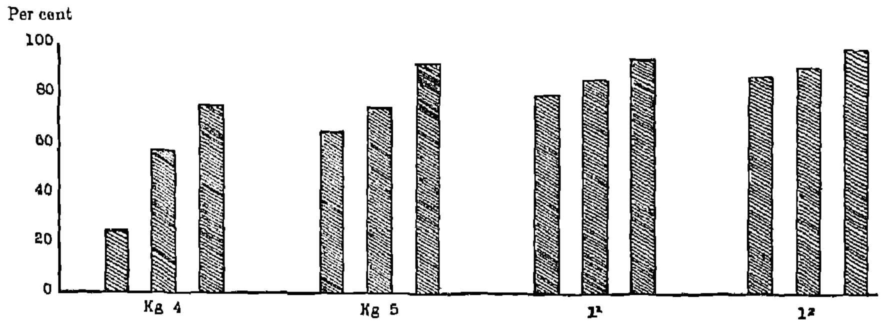

FIG. 2. PERCENTAGE OF ITEMS CORRECT ON THREE SUCCESSIVE TESTS

Individual differences

Wide individual differences in score were present in all groups in all tests except the third series. The range and central tendencies of items correct for all groups is presented in table 2. In the case of grade 1^2 approximately all pupils made perfect scores with the result that individual differences practically disappeared. By the time this stage in the learning was reached practically all the pupils in the experimental groups had attained complete mastery of the skills to be performed. This period coincided with the end of the second grade. The range of individual differences becomes smaller from the first to the third test indicating that perfect achievement in the task set is being attained.

Differences were also apparent in the amount of gain in score of correct items. Gains were naturally largest between the first and second tests of

TABLE 2

	LOWEST	MEDIAN	HIGHEST
First test			
Kindergarten 4	1	10	39
Kindergarten 5	14	42	58
Grade 1^1	24	52	61
Grade 1^2	43	56	61
Second test			
Kindergarten 4	5	39	51
Kindergarten 5	27	45	60
Grade 1^1	36	55	61
Grade 1^2	45	57	61
Third test			
Kindergarten 4	10	48	59
Kindergarten 5	43	60	61
Grade 1^1	49	61	61
Grade 1^2	60	61	61

the kindergarten group for most of the pupils of this group were in the beginning stages of learning. A tabulation of the gains for the 21 pupils of the kindergarten 4 group shows the following facts:

Points gained—first and second tests

LOWEST GAIN	MEDIAN GAIN	HIGHEST GAIN
4	21	41

Number and letter reversals

The tendency to make reversals, that is to invert the number or letter in a lateral direction, for example to make a "b" instead of a "d" was practically universal in the youngest groups of children. Instead of being a pathological sign as it is commonly supposed to be, it appears to be in younger pupils a definite stage in learning to make symbols correctly. The number of pupils in the present experiment who make one or more reversals on the first test is as follows:

Kg. 4.......................... 19 of 21
Kg. 5.......................... 14 of 16

Grade 1^1...................... 17 of 20
Grade 1^2...................... 16 of 21

The actual percentage of reversals made by the four groups of pupils in the three successive tests is shown in table 1. As might be expected reversals are much more prevalent in the younger groups and on the first test than in older groups and later tests. The results for the third test of the series indicates that by the time the pupils of groups 1^1 and 1^2 had reached the end of the second grade the tendency to make reversals had practically disappeared, although the tendency was quite prevalent at the time of the first test, and was especially so in the case of the four year pupils at the time of the first test. Observation of these children at work gave unmistakable evidence that the youngest children in the beginning stages of learning to make numbers and letters frequently have no clear notion of the direction in which the letter or number should be turned. In many cases it appeared to be purely a matter of chance whether a letter was turned to the right or to the left, and hesitation and great indecision marked the performance until the final choice of direction was made. There was also equal confusion as to which letter or number should come to the right or to the left in writing letters or numbers of two or more units. Although no separate tabulation of data was made on this point, this type of error appears to be as common and frequent as the case of reversing single letters or digits. In both the Kg. 4 and Kg. 5 groups there was a slight rise in the per cent of reversals from the first test to the second test and at the same time fewer omissions of items. On the other hand, the third test indicates in these two groups a decrease in the number of reversals made. These may be chance results due to the small number of cases involved, or they may actually be indicative of trends in learning. Younger children always made more attempt on second and third tests and it is reasonable to suppose that the increase in attempts would also result in an increase in different types of error. The children tended to make more reversals when

writing from memory than when copying, a result that was fully to be expected. Perception is more accurate when one has a sample of the symbol before him than when the memory solely must be relied upon. The elimination of reversals appears to be effected in part by maturation of perceptual powers and increased experience, familiarity, and by training in writing. In the 1^2 group there was one child who still persisted in making reversals on the third test, and in the 1^1 group, seven children who made from one to five reversals on the third test. There are occasional reports in psychological literature of persons who so consistently write in the wrong direction that they are termed "mirror writers." Of the pupils in the present experiment there were no individuals whose reversals were so consistent or so frequent as to constitute mirror writing. Of the reversals made there was not a high degree of consistency from one test to the next, nor in the children who made the reversals except in a very small number of cases. A child might make reversals on the first test and none nine months later on the second test, or he might reverse certain numbers or letters at the first test and reverse different ones at the time of the second test. As an illustration of the large amount of chance that enters into the child's choice of direction one's child's case is revealing. He said to the examiner when attempting to copy a figure three, "Please help me. Which way shall I turn it? I don't know—I'll turn it any way." The three was made reversed.

Reversals are by no means the only type of wrong letter construction although they constitute one of the commonest types of errors in the early stages of learning, possibly because the type of error is an easy one to fall into. Occasionally children made letters upside down or at an angle. The percentage of upside down scores is indicated in table 1. Considering the possible number of ways in which an "s" can be made even though the actual form of the letter is essentially correct

we gain some conception of the magnitude of the child's learning task in learning the right letter orientation. "S" and "n" are naturally the letters in which most difficulty occurs, and the errors seen most frequently on sign boards made by uneducated people, for in each case the bottom half of the letter is simply the reverse of the upper half.

Since younger children make reversals more frequently than older children and in the present experiment, at least, overcoming reversals was in large part due simply to gain in experience with age, in maturity of perception due to inner maturation, it would appear that some amount of reversal in number and letter construction is to be expected in early stages of learning, that in some cases the difficulty will be overcome without unusual training as the child matures, and that a rather definite level of maturity must be reached before the child can be expected to eliminate the tendency of making reversals. What this level of maturity is I should hesitate to state with so

limited a number of pupils of better than average maturity to start with.

A great deal has been written about the supposed interference with reading caused by a habit of making reversals. There is some slight evidence from the present data that ordinary instruction in reading and writing tends to correct a tendency toward reversals. This is naturally to be expected since reading and writing afford the child a chance to become more fully acquainted with the appearance of numbers and letters. There was also some indication that young pupils who had had least help from parents or teachers, who had been interested in making the symbols all by themselves showed the most tendency to make reversals. To such pupils the end result probably looked as satisfactory one way as another, and the child, since he learned nothing to the contrary, persisted in the habit.

Whether or not the habit of making number or letter reversals is a bad sign or is to be taken seriously depends probably more upon the age, experience and maturity of the child than upon any other factors. It is as these results indicate apparently a healthy and natural sign in the case of young bright children before school instruction has begun.

Handedness and reversals

The relation of handedness to the tendency to make reversals has never been completely established. Some authorities detect considerable relationship, others can detect none. A number of extreme cases of mirror writers have been discovered who are at the same time decidedly left handed, but whether these cases are the exception or the rule has never been determined. They may have come to the attention of research workers simply because the combined difficulties attracted unusual attention, or it may be that the two tendencies have an inner relationship and in consequence appear together in the same individual. Among the pupils of the present experiment the number of left handed children was too small to establish any rules or principles regarding the incidence of handedness and a tendency to make reversals. Such results as were found will, however, be cited. The data are limited to the first test but include all groups of pupils. Handedness was determined by observation of the children at work in using tools, pencils and in handling materials. Only those children were considered left-handed who invariably used the left hand in a wide variety of activities. Such a test is, of course, not a technical test of handedness but it constitutes a practical test that is adequate for the present purpose. A comparison is here given between left-handed pupils and those who were not left handed in the percentage of reversals made on the first test.

	NUMBER OF CASES	LEFT-HANDED PUPILS	TOTAL GROUP OMITTING LEFT-HANDED PUPILS
Kg. 4	2	.049	.059
Kg. 5	2	.18	.085
Gr. 1[1]	3	.054	.060
Gr. 1[2]	3	.08	.051

The differences are practically negligible but consistent from group to group. The cases are too few in number to establish the fact as a general principle. There were in the

experiment individual cases of right-handed pupils who tended more strongly than any of the left-handed pupils to make numbers and letters backwards, but since there are so many more right-handed pupils than left-handed pupils the comparison is scarcely fair for the larger the number of cases the greater the possibility for the appearance of exceptional cases of all kinds.

Relation between reading and writing instruction and success in making numbers and letters

Group 1^1 had received no formal school instruction in reading and writing up to the time of the second test whereas group 1^2 had from the beginning of the year instruction in reading and toward the middle of the year some instruction in handwriting the amount of which was increased toward the end of the year. In group 1^1 an activity program was substituted for the usual reading and writing instruction. It is therefore interesting to compare the two groups on the basis of success with the test in view of the marked differences in their school training.

	PER CENT CORRECT			GATES READING TEST (SCORES AT END OF SECOND TEST)
	Test one	Test two	Test three	
Group 1^1..........	.804	.875	.930	5
Group 1^2..........	.899	.906	.997	41

Rank correlation, reading and perception tests, .548.

The good showing of group 1^1 on test two which was given just before instruction of these pupils in reading and writing was begun indicates that the school training factor had little effect on the specific skills required for success in the perception test. The groups did almost equally well in spite of marked advantage of one group over the other in training in reading and writing skill. It may be assumed that the children's natural curiosity to learn coupled with natural maturity in perception and motor control enabled them to learn numbers and letters incidentally without formal instruction. Practice effect from the test may to a small degree have constituted training, but the time interval of nine months between tests precluded the possibility of much training from that source. The pupils of these two experimental groups had previously been roughly equated for another experiment on the basis of mental maturity, chronological age and kindergarten experience. The reading scores of the two groups indicate a substantial difference between the achievement of the two groups, but the difference between the two sets of perception scores is less significant. The children of group 1^1 show a high degree of success in making numbers and letters in spite of no formal school instruction in reading or writing. The slight difference in median I.Q. of the two groups, 117 for group 1^1 and 122 for group 1^2, may possibly account for all the difference found. The rank correlation of .548 indicates a fair amount of correlation between reading and perception scores.

Writing from memory versus copying

For the numbers 2, 3, 4, 5, 6, 7, 8, and 9, and the letters B, R, D, E, C, M, G, K, N, P, S, H, an opportunity was

given the child both to write the letters and numbers from memory and to copy them from samples provided on the test paper. The superiority of success when copying over writing from memory is shown in these results for the two groups on the second test:

	PER CENT MEMORY	PER CENT COPYING
Numbers		
Kg. 4	.226	.609
Kg. 5	.547	.928
Letters		
Kg. 4	.531	.791
Kg. 5	.551	.956

Letters are obviously more readily writen from memory than are numbers in the case of the Kg. 4 group.

Sex differences

The statement is frequently made that girls are more easy to instruct than boys in the early school years because of the fact that girls are more mature physiologically than boys at the age of five and six, more mature in muscular development, and consequently better able to do hand work skillfully and neatly. Since relatively fine motor coördination, ability to sit still and to pay attention are factors in successful achievement with the present tests we might expect the achievement of the girls to be higher than the achievement of the boys. The number of boys was practically identical with the number of girls in all but the five year group where there were six boys and ten girls. Pupils of groups 1^1 and 1^2 were treated as one group in studying sex differences in accomplishment. The results for boys and girls separately in terms of per cent correct are as follows:

	FIRST TEST				SECOND TEST			
	Number of cases		Per cent		Number of cases		Per cent	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Kg. 4	11	10	.241	.242	11	10	.453	.68
Kg. 5	6	10	.538	.706	6	10	.663	.734
Gr. 1	20	21	.835	.869	20	20	.923	.896

Although there is consistently slight superiority of girls over boys the differences are too small to be considered significant and the number of cases is too small to admit of generalization.

Relation of success in the perception test to intelligence as measured by the Binet test

The results so far indicate that success with the perception test is a function of age. Correlation with intelligence or mental maturity is also a function of age and it is therefore logical to assume that there would be some correlation between intelligence test scores and perception test results. For the purpose of studying the relationship of the two sets of data two groups of pupils were selected on the basis of Binet I.Q. and chronological age. The age factor was kept constant by matching pupils for age. The two groups of pupils selected had I.Q.s above 125 or below 115 respectively, practically insuring a real difference between the two groups in

median I.Q. The resulting data are as follows:

	Number of cases	Median I.Q.	Median age	Per cent correct		
				First test	Second test	Third test
More mature group	21	134	5–10	.723	.851	.951
Less mature group	21	108	6–0	.613	.756	.861

The differences found, though consistently in favor of the brighter group are not large. One reasonable explanation is that the perception test does not involve high level tasks. Complete success with the test is well within the capacity of the older but duller pupils. It was necessary in matching the two groups in chronological age to restrict the age range at the lower level because there were no mentally immature children in all the available data who were as young as the brightest pupils. This restriction in age necessarily limits the range of data.

Consistency of errors on retest

In order to determine the extent to which errors made on the first test were repeated on the second test the percentage of errors on the second test also made on the first test was computed. Results were obtained both for reversals and for all other types of errors combined.

	Kg. 4	Kg. 5
	per cent	*per cent*
Reversals	77	69
Others errors	60	68

In general, two-thirds of the errors made the first time were repeated on the second test.

Relative difficulty of different letters or numbers

The relative difficulty of different numbers and letters was determined by computing the degree of success the Kg. 4 and Kg. 5 groups experienced in making the symbols. In the Kg. 5 group most difficulty was experienced with numbers 5, 8, 2 and letters G, N, K, S. The easiest numbers were 3, 9, 7 and the easiest letters E, H, P. In the Kg. 5 group differences were neligible for no letters or numbers appeared to be easier or harder to construct than any others.

SUMMARY AND CONCLUSIONS

The results of a test of the ability of pupils in a four year kindergarten group, a five year kindergarten group and two first grade groups to make numbers and letters indicates gradual progress from a low to a high degree of success, for three repetitions of the test at nine month intervals. Types of responses scored include items correct, part right, reversed, upside down, items omitted and items wrong. Almost perfect scores were attained by the groups of pupils who had reached the end of the second grade at the time of the third test, indicating mastery of the skills involved in the test. Individual differences were present in all groups and for all three tests, though the differences were of a narrower range in the groups of older children at the time of the last test because of the fact that maximum achievement was prac-

tically reached by these pupils. The type of error termed a reversal, that is, the lateral inversion of a letter or number, appeared to be practically universal in the younger groups of pupils. These errors were gradually eliminated as results from the third test in the series indicate. There was apparently no relation between handedness and the tendency to make reversals in the small number of cases for whom data are available. There was only moderate correlation between reading test score and experimental test score and the experimental test score of pupils who had no reading or writing instruction up to the time of the second test was practically as high as that of pupils who had had reading or writing instruction, suggesting the independence of success with the test and reading instruction. Writing numbers and letters from memory proved to be a more difficult task for little children than making a copy of material given them. Sex differences were so slight as to be practically negligible, yet they were almost consistently in favor of the girls. Two groups of pupils matched for age but differing significantly in mental maturity differed in success with the experimental tests by small per cents and these differences were consistently in favor of the brighter group. A large amount of relationship is not to be expected since the material of the experimental test is of a comparatively low order of difficulty and perfect achievement is well within the capacities of the older and duller pupils. Comparing the errors made on a retest with errors made on the initial test, the amount of duplication of error on the second test is on the average about two-thirds the amount of error on the initial test. There was some evidence from a tabulation of correct responses for separate symbols, that certain letters and numbers are harder to make than others.

Implications for education: Large amounts of error are to be anticipated in the acquisition of skill in making numbers and letters on the part of young children. Individual differences are universal and should be detected as early as possible. Since reversals are practically universal in early stages of learning, they may be considered as rather logical errors in the learning progress of young bright children. One need scarcely anticipate that young bright left handed children are any more likely than right handed children to make reversals. Factors more important than handedness or school instruction appear to be informal opportunity to learn and inner maturation in perceptive and motor abilities. Knowledge such as that gained from the tests used for the present experiment should be available when formal instruction in handwriting is begun so that slower and faster learners may be given instruction appropriate for their needs. Practice can then be directed toward overcoming the specific errors the pupil consistently makes and can be placed on numbers and letters that experience shows are most difficult for pupils to make.

Theories and Measurement of Attitudes*

Mandel Sherman

Studies of attitudes have been so numerous in the past ten years that the review of every article published in this field is hardly profitable because of the many repetitions and generalizations. As far as possible only those publications dealing with theories and experimental methods of measuring attitudes are reviewed. And because many writers have published the results of experiments both with adults and children some of the work on adults is also included. The publications cited are selected as being representative of the various students in this field. Additional references are given, part of which represent less definite studies and part of which repeat the statements of the authors cited.

Definitions in use by writers on the subject of attitudes have involved extensive controversy because nearly every experimenter has set up his own definition. An attempt to develop a concise definition of the term from the sociological standpoint was made by the Committee on Education for Citizenship, as quoted by Voelker (42):

"an attitude is properly settled behavior, a settled manner of acting because of habitual feeling or opinion. Three factors or aspects are here present, (I) an habitual mode of thinking, (II) a settled interest; (III) a settled mode of acting as growing out of habitual feeling or thinking. These three aspects give rise to three types of attitudes, according as one or the other element is emphasized: (I) a 'point of view' (apperceptive attitude); (II) an 'interest'; (III) an action attitude."

Faris (15) challenged the school of behaviorism for its attempt to limit behavior to observable movements, saying,

"The attitude is in part the residual effect of the act, but it remains as a predisposition to certain forms of subsequent activity. The motive or intention is an integral part of the act, and no estimate of the quality of the act can be made without considering the inner experience. . . . . Attitudes exist as tendencies to act; they are subjective, and therefore difficult to investigate; but many invisible objects can be studied, and a great many competent men are now engaged in research with every promise of notable success."

Other writers have used some such definition as "a set of mind which determines ones response to particular situations." To those who are accustomed to think of "mind-set" in philosophical terms this definition is quite acceptable because of its brevity and apparent familiarity. But for those who are accustomed to think of psychological phenomena in more

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scientific terms this definition is altogether too vague and philosophical. To many the term "mind-set" implies that the individual will react in a definite way under most conditions according to the attitudes he has developed. But most people realize that the behavior of an individual is entirely too variable, due perhaps to the variability of environment, to be measured in terms of attitudes, at best only a philosophical concept.

The definition of Chave (10) that an attitude is a complex of feelings, desires, fears, convictions, prejudices or other tendencies that have given a *set or readiness to act* to a person because of varied experiences, appears to be more concise and acceptable than most definitions used by sociologists until the statement is closely analyzed. For again, the term "set" is employed and the definition ends weakly with "because of varied experiences." The questions readily arise, What experiences? How do experiences develop attitudes? What are tendencies? When do tendencies materialize in behavior? Perhaps one should not be too critical because precise definitions of subject matter are extremely difficult to construct even in the exact sciences. The definition used by the group at Colgate University (3) is that an attitude is a general emotional and intellectual predisposition to act in a positive or negative direction as a result of personal experience and inborn tendencies. One wonders whether the authors have not attempted to be all-inclusive by trying to please everyone with the phrase "personal experience and inborn tendencies." Each writer in this field has struggled with the term, believing that only after defining the term is he able to go on with his experiments.

Faris (16), after discussing the quibbling that is current about the definition of the word, says, "But whether we speak of attitudes, of habits, or tendencies, or of dispositions is no great matter. In fact it is utterly irrelevant if so be that we are careful to know just what we are talking about." However, later in the same article Faris quotes Dewey (12) on the nature of an attitude, "an acquired predisposition to ways or modes of response, not to particular acts except as under special conditions, these express a way of behaving." This quotation by Faris containing the phrase, "acquired predisposition" is interesting when we refer to an article written by him in 1924 (14) in which he divides attitudes into several categories, the first of which is the two groups of hereditary and acquired attitudes. In his recent writing (16) much emphasis is placed by Faris on the fact that attitudes are not acts, they are predispositions, and therein lies one of the main problems in their study, ". . . . in strict phrase, an attitude, however real, must always be inferential." In the same volume Bernard (4) states that, "An attitude is an incompleted or suspended or inhibited act."

It is evident that unlimited time can be spent in listing the various definitions of the term attitude and the inconsistencies and differences in the statements of various workers. It is just possible that because attitudes have been studied in an experimental

way for only the past few years that the workers have not yet reached the stage at which they are more concerned with the experiments than with definitions of the term. We know, for example, that a large number of excellent studies have been made on intelligence but we still can be involved in controversies regarding its definition.

THEORIES OF THE MEASUREMENT OF ATTITUDES

Although attempts in objectifying studies of attitudes have been made only in the past twenty or twenty-five years, the subject of character, which is closely allied with attitudes, has been studied for more than two thousand years. Records show that one of the earliest character analysts, a so-called employment consultant, Theophrastus of Eresos, lived between 372 and 288 B. C. Between that period and the modern period of psychology sporadic attempts have been made at the explanation of human behavior in terms of character development. The term attitude has been used indiscriminately in the past (as well as at present), for the most part in the attempt to explain the intangible and intricate responses of man.

The modern theories about attitudes and their measurement are confined in this review to the work which has been done since 1920. In the past two or three years the subject seems to have become more confused because of the variety of workers entering this field—from political economists to psychologists and psychiatrists.

In 1920 Rugg (34) incorporated his positive theories of the measurement of attitudes in a rating scale using the man-to-man-comparison method. However, at this time others were not as convinced as Rugg of the validity and feasibility of measuring attitudes. In the following year Rugg (35) published his definite theory that the rating of human character is practical if it is done under the following conditions: "First: If each final rating given a person is the average of *three independent* ratings, each one made on a scale as objectified as the man-to-man-comparison type of scale. Second: If the scales on which the ratings are made are comparable and equivalent, having been made in conferences under the instruction of one skilled in rating scale work. Third: If the three raters are so thoroughly acquainted with the person rated that they are competent to rate." In a publication the same year the Allports (1) seemed to agree with Rugg when they stated that, "A well controlled process of rating individuals by associates is probably an adequte means of obtaining an objective notion of a group of personalities with which the results of tests devised for this sort of measurement may be correlated." The phrase "objective notion" is indicative of the lack of confindence at that time. They stated that their work was "to be regarded as merely the beginning of the investigation of personality." Later Allport (2) stated that ranking was a more objective method than rating.

Rugg (35) gave much credit to the work of Elliott who made one of the first suggestions for a rating scale in 1910. Rugg was one of a group of trained school officials who tested this

scale but obtained no significant correlations. The value of Elliott's work was in stimulating the development of rating scales. The Elliott Scale as well as the Boyce Scale was soon discarded and the first real progress in this field was made by a class at the Carnegie Institute of Technology in 1917 in the development of the man-to-man-comparison scale. This scale was utilized by Rugg in constructing his rating scale in 1920. W. I. Thomas is also credited with stimulating an interest in the study of attitudes.

From this time on many studies were undertaken using both the self-rating scales and the rating by teachers, parents and friends. Some workers found a high degree of discrepancy between self-rating and rating by others. Knight and Franzen (28) pointed out that in self-rating it is the tendency of the subject to overrate himself. Hughes (24) criticised the rating schemes then in existence and stated that the first requirement for the validity of a rating scheme is met only in the degree to which the rating situations are similar to normal life situations. He was also one of the first to show that a rating scheme is valid only when the individual is "himself" at the time of rating. He stated that the validity of a rating can be checked when there is agreement between the actual reactions of the individual and the results of the rating. This is precisely the difficulty which confronts many workers at present. Many theoretical traits are constructed on which the examinee is to be rated or rates himself with little relationship between his actual experiences and the questions asked. And few, if any, studies have been attempted to correlate the results of the rating with the actual behavior of the individual. Some students have pointed out that the difficulty of checking on the rating is too great and would require too much time.

In her comprehensive review and summary McDonough (29), in 1929, stated that the methods of studying character are as yet in the experimental stage and far from perfect. Watson (44) in 1925 pointed out that although the attitude of fair-mindedness could be measured there are many difficulties in accepting attitude measurement as valid. He appeared to be somewhat in doubt about the meaning of the results of his test. In many respects Weinland (46) was of the same opinion when he stated,

"In measuring attitudes however two differences from the intelligence testing program will have to be noted. First, since it complicates matters exceedingly to designate right attitudes and wrong attitudes while it may be perfectly possible to measure different attitudes, the norms will not be based on the number that answer right or wrong. The norm will be merely the average response to a given situation. . . . . One choice will, of course, not evince an attitude, but fifty choices or one hundred may, particularly when the choices of different people are contrasted according to some principle, such as sex, group uniformity, and so on. And when the situations to which choices are asked have been experimentally selected for their diagnostic value definite results can be obtained. And second, ... the norms should probably be established for different groups such as college students, doctors, lawyers, salesmen, and so on, rather than for different age levels or ability levels."

Not until very recently has a positive feeling regarding the feasibility of measuring attitudes seemed to per-

meate the literature. Nevertheless, those who believe that we have finally reached a stage of precision in measuring attitude are entirely too optimistic in view of the results of experimental studies. Olson and Jones (32) seem to have been too optimistic when they stated that, "Attitudes can no longer be considered to be unmeasurable. The work of Thurston, Watson, Chave, Droba, Hart, Jones, and others have indicated that it is feasible to measure attitudes reliably in cases where the subjects are sufficiently coöperative to answer truthfully various questions which are put to them." First, there is no reason to believe that attitudes have been measured reliability as yet. And second, when these authors state that attitudes can be measured in cases where the subjects are sufficiently coöperative to answer truthfully, the question naturally arises whether the measurement of attitudes does not include the method of making the subject respond coöperatively and truthfully. Indeed, the problem of the subjects' coöperation and truthfulness has complicated the entire field of psychiatry whether in studies of attitudes, emotions or personality. If we are sure the subject is coöperative and truthful we hardly need the many intricate tests in existence at present.

It is evident that sufficient experimental studies have not been made and that many investigators are still concerned with controversies regarding the definitions and theories of the measurement of attitudes. There is also great discrepancy in the use of the term "objective." Some writers believe that if their tests can be repeated on the same subject with similar results that their method is highly objective. Others point out that a so-called objective test may be highly subjective on both the initial examination and on its repetition.

METHODS AND RESULTS

In 1924 Starbuck (38) sent out a questionnaire in an attempt to learn the prevailing interest in the study of character and personality and the current theories. From the replies he received and the bibliographies on the subject, he stated,

> "it appears that there are at least one hundred and fifty professional psychologists and other educators working at the problem by methods that approach scientific refinement. The prevailing attitude is clearly one of confidence that we shall be able to analyze out the elements of character, define its types, and discover the limits within which it is possible to cultivate it. Only four persons among my respondents expressed doubts concerning the present and future of character tests and measurements."

He also stated that the following methods of approach were being used:

> "Direct observation of individual cases. Psycho-analysis. Association tests. Genetic and developmental studies. Self-analysis and self-measurement. Other rating by scale. Objective methods. Reference-judgments. Expressional reactions, other than judgmental. Experimental methods. A study of character types by all methods hitherto described."

The description of the different methods in use in the measurement of attitudes is difficult because in many cases there is no clear-cut separation of the technics employed. The methods can be divided in a rather loose and descriptive way into: rating scales, questionnaires and tests, and mechanically-objective measurements.

Three types of rating scales generally have been employed: self-rating, rating by others, and ranking.

Self-rating:

1. The subject makes an absolute judgment of the presence or absence of the given traits in himself.

2. The subject checks the point on a numerically arranged scale which he believes represents the degree in which the trait is present in himself.

3. In the use of paired adjectives, one desirable, the other undesirable, the subject checks the one which he believes applies to himself.

4. In the man-to-man-comparison, the subject compares himself with the "scale men" (previously selected by the experimenter).

Rating by others necessarily involves those who know the subject, or subjects, well, including teachers, parents, friends, and acquaintances, and follows the same scheme as in the self-rating method.

Ranking may be done either by the examinee or by others:

1. In self-ranking the examinee shifts any given number of words and phrases written on separate slips of paper into the order of merit he believes they represent in the living of life.

2. In ranking by others, the observers rank the persons by arranging them on a sliding scale from the highest to the lowest according to the degree in which they possess the given traits. Many workers have considered this method more objective than the rating scales previously described.

The most commonly used method of measuring attitudes has been by questionnaires and tests, which involve the answering of questions, either orally or in writing, by the subject himself or by others about the subject. The replies are analyzed for their diagnostic value. The most generally used forms of questionnaires involve:

1. Crossing out of words which are distasteful or which are considered irrelevant.

2. Word association. Upon hearing the stimulus word the subject immediately responds with the first word which occurs to him.

3. Series of questions to be answered:

a. By yes or no, or true or false. Some investigators have carried this method further by requiring the subject to go back over the questions after having answered them all by either yes or no, or true or false, and to underline the answers to the ten questions on which he feels strongly, then perhaps to double underline the five on which he feels most strongly of all.

b. By written answers which may involve only brief replies but may also involve lengthy ones concerning perhaps the solution of social problems, etc.

4. Series of situations are described involving choice, following each one of which are three or more solutions or responses from which the subject selects the one he would use.

5. Statements of fact are given, each followed by several conclusions. The subject is to check only those conclusions which are established by the facts given in the statement itself.

Many so-called tests are similar to forms described under questionnaires, but the following methods distinguish

them as tests rather than questionnaires:

1. Series of pictures to which the emotional responses of the subject are recorded.

2. Series of photographs or pictures for the subject to identify.

3. Series of problems to be solved, either mathematical or pictorial completion.

The phrase "mechanically-objective" has been used to identify the third group in the classification of methods in order to distinguish it from the many other so-called objective measures which utilize voluntary responses from the individual as the basis of measurement. In this group the involuntary responses are measured. A description of the method is given subsequently.

A study on self-rating was published by Washburn and Stepanova (43) based on the earlier work of Hollingworth (23) whose study revealed a tendency of college students to overrate themselves on desirable traits. These two investigators made what they considered two improvements in Hollingworth's method. First, instead of comparing the members of a group among each other and arranging them in order of merit, thus using a relative standard, their observers made absolute judgments of the presence or absence of certain traits: and second, they used a set of traits in which the factor of complimentariness or uncomplimentariness was reduced to a minimum. The investigators suggest two important influences as affecting the relation between judgments of self and judgments of others on oneself. The first relates to whether the trait judged is one that is habitually repressed in society. People do not give free social expression to such traits but may be aware of them in themselves, so therefore rate themselves higher on them than do their friends. Second, traits which are socially desirable refer to an ideal standard which will be higher in proportion as a person's performance judged by others is more excellent. In other words, a really careful, industrious, orderly and punctual person is not satisfied with his own performance. Hence they interpreted their results as showing a tendency for a person to under-estimate his own possession of desirable traits when his own judgments are compared with those of his companions on himself. These results are at variance with the results of other studies which showed that individuals tend to over-rate themselves on desirable characteristics.

The study of Hurlock (25) showed a tendency for children to over-rate themselves on desirable personality traits. Of 12,690 responses made by the 423 children, only 763, or 6 per cent, related to socially undesirable character traits.

In general, the results have shown that rating by others is a more satisfactory method than self-rating. Moore and Gilliland (31) used the ratings of teachers and of close acquaintances on students' aggressiveness as the method of selecting the two groups used as subjects in their test of aggressiveness study. After using the method of rating by others in a study, the following conclusions were reached by Cleeton and Knight (11): "1. The ratings of close associates are

reliable. 2. The ratings of seventy casual observers are reliable. . . .4. The correlation between ratings of close associates and causal observers is slightly better than chance." May and Hartshorne (30), who have done extensive work in the measurement of character traits, have used this method of having teachers rate the children, and the pupils rate each other, in combination with other devices.

The most commonly used method of measuring attitudes, as mentioned previously, is that of tests and questionnaires. The popularity of this form of investigation is aptly described by Faris (16):

> "The early reaction to the doctrine of attitudes obscured this fact (that attitudes, however real, must always be inferential) by assuming that attitudes are immediately revealed in the opinions and statement which are easily obtained by direct approach. And this inaugurated a questionnaire era of research on attitudes. Subjects checked off prepared statements, or filled in dotted lines, or responded to interviewers, the statement recorded being assumed to have immediate and unequivocal relation to the attitudes."

Droba (13) criticized the careless and unscientific preparation and organization of the majority of questionnaires. He objected to the method of using several forms of statements in the same test. He divided the types of statements in general use into three categories: the impersonal form, the personal form and the question form. He believes that the question form does not represent the opinion as well as the non-question form for the weight of the opinion lies in the response rather than in the question, while in the non-question form, the statement rather than the answer, is the opinion.

Thurstone (40) and Chave (10) attempted to objectify measurement scales. Through the application of statistical methods in the make-up of the tests and questionnaires they have attempted to eliminate some of the weaknesses of attitude measurement. The statistical work has confused many about the problem of attitudes. While it is admitted that statistical technics enable the examiner to scale the answers accurately, such work has proven very little about the validity of measuring attitudes. For the real question involved is whether the responses actually indicate a disposition to act in a given way rather than whether the answers can be scaled. The work of many in this field has shown that opinions are often obtained which are interpreted as steadfast attitudes but which actually have little or relatively little to do with the personality pattern of the individual. The statistical flare in scaling replies must be considered as a statistical technic and not as a method of measuring or validating attitudes. A somewhat analogous situation exists in the social intelligence tests where a given measure may be reliable statistically, but does not prove that social intelligence is being measured. It has been shown that most of the social intelligence tests are merely modified intelligence tests.

Many other forms of questionnaires and tests have been developed to measure given attitudes. Hart (21) published a study from the University of Iowa for which he developed an instrument for measuring the socializa-

tion of various groups of individuals by using tests containing words, phrases, and sentences to provoke contrasted sorts of reactions in persons having contrasted social attitudes and interests. Shuttleworth (37) adapted a form of the Hart test and used it to study attitudes toward money and wealth. Another well-constructed test was that of Watson (44) with which he measured fair-mindedness as contrasted with prejudice or bias upon certain religious and economic issues. A test was constructed by Travis (41) to diagnose character or personality through the use of fifty psychological and psychoanalytic terms selected as representing a number of mental-sets and personal attitudes. Symonds (39) arranged a questionnaire of one-hundred questions to study social attitudes as criteria of educational trends and a test of the objectivity of education.

Hartshorne and May (22) have used tests and questionnaires quite extensively in their work. One of their early publications was a report on their study of children's knowledge of right and wrong in which they utilized three tests. They used statistical methods in evaluating their results. Furfey's (18) objective test for measuring developmental age had a reliability of .76. It consisted of four parts concerned with play interests, reading interests, and attitudes to various ideals; and was validated against age and a rating scale. Other studies along this same line were done by Jones (26) (27) in the field of character guidance. He attempted to construct his test objectively and evaluated the results statistically. Weinland (46) attempted to develop an objective method of measurement of attitudes through the use of plus and minus signs in agreeing or disagreeing with fifty selected proverbs. Other representative investigators who have used the test and questionnaire method in their studies are: Filter (17), Ream (33), Burtt (7), Gates (19), Bird (5), Charters (9), Chambers (8), Gilliland and Burke (20), Wrenn (47), Weber (45), Shales (36), Bowden (6).

The phrase "mechanically-objective" is applied to the study of Olson and Jones (32), and because of the experimental nature of this work a brief summary of the method and conclusions are given.

A series of words and sentences bearing upon four controversial issues, religion, race, social relations, and economics and politics, was arranged for college students with a view to stimulating responses which would reveal emotionally toned attitudes toward these issues. The method used was an adaptation and extension of the Audrucksmethode employed by Luria in his investigation of criminals in Russia. The method consists of recording on a kymograph record the tremors and other responses of both hands preceding and accompanying the verbal responses to each of a series of words and sentences, which were called to the subjects in rapid-fire manner by the experimenter. The subjects were directed to give a verbal response to each word and sentence as promptly as possible and simultaneously to press down firmly with their fingers upon two rubber discs. The fingers were resting on these discs at all times, and therefore it was possible

to study the hand responses just preliminary to the main responses. These preliminary responses were supposedly significant. They appeared to record either amounts of tension prior to the main responses, or else the beginnings of responses which the subject endeavored to inhibit. Measurements were made of the heights of these preliminary runs on the kymograph records. A statistically reliable difference was obtained between the preliminary responses to the experimental (or controversial) and the control words and sentences.

Only small agreement was found between the test results and the judgments of fellow-students in ranking the subjects from the highest to the lowest as to the strength of their emotionally toned attitudes. It was the investigators' belief that while this low correlation was due in part to the errors of measurement in the test, it was also due in part to the unreliability of ratings.

It may be interesting to compare this work with the early study of Moore and Gilliland (31) on two conflicting points. One of the tests used by Moore and Gilliland was a word association test. In the first set-up of their apparatus a lip key as a recording device in circuit with a chronoscope was used. But the experimenters considered this unsatisfactory on account of the frequency with which the subjects tended to make lip movements, or even began to vocalize, before they were ready with the final response. These preliminary movements were considered as spoiling the record, and this method was discarded. As we have seen, Olson and Jones, considered these preliminary responses as significant and they form the important data of their study. The second conflicting point was the oral presentation of the stimulus words. Moore and Gilliland considered the oral presentation of the stimulus words unsatisfactory because of the possibility of slight misunderstandings, and the slight variations in emotional suggestion on the part of the experimenter. They therefore developed an apparatus like a motion picture screen on which the experimenter caused the words to appear at the desired intervals by means of a hand control. Olson and Jones, on the other hand, did not consider any variations in the voice or technic of the experimenter sufficiently important to substitute a more objective method for the oral presentation.

From the representative theories and methods cited in this review it is evident that relatively little progress has been made in the study of attitudes. One of the main difficulties has been in the assumption of the experimenters that the replies of the subjects indicated their true tendency to act in a given way. Those who criticize the present-day method of studying attitudes point out that what the examiner obtains is an opinion which in many cases is not the true opinion of the subject. Furthermore, the opinion of an individual often has relatively little relationship to his true attitude. And the questions or situations of the test may have little relationship to the actual experiences of the subjects. Few experimenters have taken into account the inhibitions that a person has in admitting his true

attitudes even to himself. This the psychoanalysts have pointed out in their studies of the distortion mechanism of dreams and phantasies.

From the literature it appears that the most reliable methods of studying attitudes thus far developed are those which take into account the possible inhibitions and distortions of the individual and in which the question or situation approximates the previous experiences.

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The Food Consumption of Nursery School Children*

Mary S. Rose, Elda Robb and Gertrude M. Borgeson

IT IS now over five years since the Child Development Institute of Teachers College organized its nursery school and initiated its nutrition service. During this time a consistent effort has been made to apply in the daily feeding of the children all that the modern science of nutrition has discovered regarding the best conditions for optimum health and normal growth. A nutritionist trained in nutrition, in child development and in education has not only been in charge of food preparation and service, but has been in daily contact with the mother or some other responsible guardian of each child in order to see that there was the best possible articulation between the home and the school, and has maintained close connections with the pediatrician, the nurse and the nursery school teachers.

In the nursery school the child's eating is very intimately bound up with the whole educational procedure. He enters at the age of eighteen months, perhaps. He is growing fast and must be fed in such a way as to promote development and avoid the evils of fatigue, indigestion, or malnutrition. Moreover, eating habits must be fostered which shall be desirable not only from psychological and social view points, but shall serve to lay the foundation for vigorous health in adult life as well as in the immediately succeeding years.

Articulation of the school program with the home program is necessary in order that the total food needs for the day shall be met every day. The meals must fulfill nutritive requirements, and must also be prepared and served in ways easy for little children to eat and digest, and in ways that foster desirable attitudes towards foods essential for healthy growth.

The nutritionist was always at hand when the children arrived in the morning, to learn about the child's breakfast and anything with regard to the time spent at home which might bear on the food situation. She generally saw the mother, too, upon her return for the child at the close of the school session, and took this opportunity to give the mother any information which might modify the home feeding program. In order to have more tangible assurance that each child was getting a well-ordered diet, a special quantitative dietary study for a four or five day period was made as soon after the beginning of each term as the children had become thoroughly

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accustomed to the nursery school régime. Graduate students in nutrition from Teachers College assisted in the collection of the data and made careful studies of the individual dietaries in relation to each child's requirements.

Blanks were furnished for records at home and at school. Records of food eaten at home were kept by the mothers, after careful discussion of the precautions to be observed to insure accuracy. The following sheet of directions was given to each parent and explained in detail. It was also checked with the parent when completed, to avoid omissions or misunderstandings.

CHILD DEVELOPMENT INSTITUTE
514 West 126th Street
New York City

GENERAL DIRECTIONS FOR FILLING OUT DIETARY RECORD

Please read carefully before beginning the record

1. Measure the food in a measuring cup or spoon in order to be able to judge amounts.
2. Make all measurements level whether cup, tablespoon or teaspoon.
3. Give all recipes on the back of the sheet.
4. Write down only the amount of food that is actually eaten.
5. Make a note if more food is served than eaten.
6. Record everything eaten between meals.
7. Note kind of bread—whether white, whole wheat, or rye; and kind of cereal—oatmeal, wheatena, etc.
8. Note whether butter is used on bread and vegetables, and sugar on cereal, fruit, etc.
9. Record the approximate amount of water taken during the day.
10. Record time of serving each meal and the approximate time taken to eat it.
11. Fill out the record blank for each meal at the time when meal is eaten.

As the children came from American homes, superior intellectually and economically, and as the parents were as a rule most coöperative and painstaking, it is felt that their records have a high degree of reliability. In any case where there was doubt of such coöperation, the record has been excluded from the survey of the dietaries for the four year period which it is the purpose of this paper to report and discuss.

During the four years from the fall of 1926 to the spring of 1930, there were two nursery school groups, one for children under two and one-half years of age, the other for children over two and one-half and under four.

In classifying the 163 children whose dietaries are included in this study, all those from eighteen to thirty months of age have been put in the group designated as two-year-olds, and all those from thirty-one to forty-two months of age in the three-year-old group. The median age for the two-year-old group falls exactly at the twenty-fourth month, and for the three-year-old group at the thirty-seventh month.

The median height for the two-year-olds is 34 inches; for the three-year-olds, it is 37.5 inches. The median weights are 28 and 33 pounds respectively. These medians closely approximate those reported in the

Merrill-Palmer Standards of Physical Growth (11) and in Woodbury's Stature and Weights of Children Under Six Year of Age (13). One three-year-old child fell below the median height of the two-year-olds, and two of the two-year-olds were above the median height of the older group. Seven three-year-olds were below the median weight of the two-year-olds, and four of the younger group were above the median weight of the older group.

The children arrived at the nursery school between 8:30 and 9:00 in the morning and stayed until 3:00 in the afternoon. On arrival after inspection by the nurse, orange juice and cod liver oil were served. At present tomato juice is used instead and the cod liver oil is served separately after the noon meal, as the children became so attached to the orange juice-cod-liver-oil combination that they complained if their orange juice had no "bubbles." Dinner, the main meal of the day, was served at noon and milk and crackers at 2:30, before departure for home in the afternoon. The noon meal at school was planned to include:

Potatoes, practically every day.

At least one vegetable other than potatoes.

Eggs on at least 3 of the 5 days and liver once a week.

Toast made of 50 per cent whole wheat bread.

or

Sandwich made of 50 per cent whole wheat bread, containing small amounts of finely chopped raw vegetable.

Milk—6 to 8 oz. (14 to 16 oz. given during the day at nursery school).

Dessert—fruit alternating with milk-and-egg dessert.

The same menu was served to each group with some modifications in the methods of preparation due to the differences in age of the children. Vegetables were pureed for the younger group and chopped fine for the older. The younger group also received less raw vegetable and for dessert, fruit more finely cut. Individual adjustments were made mainly in the size of the servings given, changes depending on age, state of nutrition, food idiosyncrasies, marked dislikes, and physical condition.

Each Friday menus for the following week were distributed to the parents. In addition to the nursery school menus, suggestions were made for home breakfasts and suppers which would supplement the nursery school diet and make the day's plan complete. A sample menu for a week is shown.

In the period under consideration dietary studies were made of the diets of 58 children in the two-year-old group, 27 boys and 31 girls; and of 92 children in the three-year-old group, 45 boys and 47 girls. In dealing with the data, no separation of the sexes seemed advisable, considering the relatively small number of cases.

In a study of children's dietaries in institutions, it has been shown by Rose and Gray (5) that the distribution of the total calories among specified food groups is a practical way of determining the adequacy of the diet for children from 5 to 15 years of age, taking into consideration at the same time the total energy intake as

NURSERY SCHOOL MENU

MARCH 11–15, 1929

Suggested breakfasts and suppers

HOUR	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Breakfast 250–320 Cal.	Cereal $\frac{1}{3}$–$\frac{1}{2}$ cup Milk 2 oz. Fruit 2–4 tbsp. Toast $\frac{1}{2}$–1 slice Butter $\frac{1}{2}$–1 tsp. Milk 6 oz.	Same	Same	Same	Same
9:15 70 Cal.	Orange juice 3 tbsp. Water 3 tbsp. Karo $\frac{1}{4}$ tbsp. Cod Liver Oil 1 tsp.	Same	Same	Same	Same
Dinner, 11:30 400–525 Cal.	Pea Puree with egg 3–5 tbsp. Mashed potato 3–5 tbsp. Toast $\frac{1}{2}$ slice Butter 1 tsp. Milk $\frac{3}{4}$ cup Applesauce $\frac{1}{4}$–$\frac{1}{3}$ cup	Scalloped tomatoes 2–4 tbsp. Creamed liver 1–2 tbsp. Baked potato 1 Toast $\frac{1}{2}$–1 slice Butter 1 tsp. Milk $\frac{3}{4}$ cup Fruit cup $\frac{1}{4}$–$\frac{1}{3}$ cup	String beans 2–4 tbsp. Scrambled egg 1 Potatoes 3–5 tbsp. Sandwich 1 slice Milk $\frac{3}{4}$ cup Butter 1 tsp. Orange Blanc Mange $\frac{1}{4}$–$\frac{1}{3}$ cup	Creamed carrots 3–5 tbsp. Potatoes 3–5 tbsp. Toast $\frac{1}{2}$ slice Milk $\frac{3}{4}$ cup Butter 1 tsp. Tapioca $\frac{1}{4}$–$\frac{1}{3}$ cup	Spinach and egg 3–5 tbsp. Potatoes 3–5 tbsp. Sandwich 1 slice Milk $\frac{3}{4}$ cup Butter 1 tsp. Prune whip $\frac{1}{4}$–$\frac{1}{3}$ cup
2:30 95–175 Cal.	Milk 4–8 oz. Graham crackers 1–2	Same	Same	Same	Same
Supper 310–400 Cal.	Cream of tomato soup $\frac{3}{4}$–1 cup Croutons 1–2 slices Milk $\frac{3}{4}$ cup Baked banana 1	Oatmeal $\frac{1}{3}$–$\frac{1}{2}$ cup Toast 1–2 slices Butter $\frac{1}{2}$–1 tsp. Milk $\frac{3}{4}$ cup Junket $\frac{1}{4}$–$\frac{1}{3}$ cup	Milk toast 2 slices Sandwich $\frac{1}{2}$–1 slice Milk $\frac{3}{4}$ cup Applesauce $\frac{1}{4}$–$\frac{1}{3}$ cup	Poached egg 1 Toast 1–2 slices Butter $\frac{1}{2}$–1 tsp. Milk $\frac{3}{4}$ cup Fruit cup $\frac{1}{4}$–$\frac{1}{3}$ cup	Cream pea soup $\frac{3}{4}$–1 cup Toast 1–2 slices Butter $\frac{1}{2}$ tsp. Milk $\frac{3}{4}$ cup Rice pudding $\frac{1}{4}$–$\frac{1}{3}$ cup

compared with estimated requirement, and the suitability of the daily program as shown by the menus. The main objective of the present study was a similar analysis of nursery school dietaries to see whether knowledge of the distribution of calories among six food groups as proposed by Rose and Gray would be helpful in evaluating the diets of these younger children.

The dietaries were accordingly analyzed for the per cent of total calories derived from each of the following six food groups:

I. Foods from Cereal Grains: Valuable primarily as a source of energy, but also contributing considerable protein, and, if whole grain products be used, capable of adding iron in readily available form, considerable vitamin B, phosphorus and other mineral elements.

II. Milk: The source of most of the calcium, much of the vitamin A and phosphorus, considerable of the vitamin B and vitamin G, as well as protein of the best quality and calories in a form easily taken.

III. Fruits and Vegetables: A well-chosen assortment should guarantee a liberal amount of vitamin C as well as other important contributions to the mineral and vitamin content of the diet.

IV. Fats and Oils: In little children's diets chiefly important as bearers of vitamin A, in form of cream, butter and cod liver oil. The fat in the composition of whole milk is counted as milk and not included in this group. The proportion of total calories from fat needs to be relatively low, lest digestion and appetite be impaired.

V. Sugars: In little children's diets sugar should be furnished chiefly in the form of lactose in the milk, which is not included in this group. Cane sugar, syrups, etc. should be used very sparingly, not to crowd out more important foods nor to disturb appetite and digestion.

VI. Eggs and Meat: For little children, it is important that caloric-bearing foods be chosen with regard to their specific growth-promoting properties. For this reason milk is given a high place in the allotment of total calories, and ordinary muscle meat, which is inferior in growth-promoting substances, is not allowed to displace more important foods. Instead, eggs, which are of great value for growth, being in this respect second only to milk, and liver which resembles eggs rather than muscle meats in its nutritive properties, are given first place in this group. With a liberal allowance of milk, this group must contribute a rather low proportion of the total calories, or the total protein intake may be disadvantageously high.

Since foods can be thus arranged in groups with fairly well-defined nutritive properties, it is possible to learn a great deal about the character of any diet by a study of the percentage of the total calories contributed by each group. For example, if the percentage of milk is low, calcium is almost certain to fall below the amount desirable for optimum storage, and phosphorus may also be too low. This method of study gives help in determining quickly which foods should be increased to improve the dietary and which can wisely be reduced in amount.

The *total* calories consumed by the two-year-olds ranged from 1000 to 1575 calories per day, the median for this group being 1275 calories, or from 35 to 55 calories per pound of body weight, with a median of 44 calories per pound. In analyzing the data, a frequency distribution was made for total calories per child per day using a step interval of 25 calories. For the three-year-olds, the range was from 950 to 1650 calories per day, the median being 1350 calories, or from 29* to 56 calories per pound, median 41 calories per pound.

In the Merrill-Palmer School (11) 33 children 30 months of age have been reported to have a median energy consumption of 47 calories per pound of body weight and 51 children 37 months old a median of 45 calories per pound.

In a study of 30 children from a children's orphanage and 25 from private homes, McKay (2) reports for 19 two-year-olds a food consumption of 41 calories per pound and for 18 three-year-olds, of 40 calories per pound. Winters (12) studied a group of 50 Texas children of nursery school age and found for two-year-old boys an average intake of 41 calories per pound, for two-year-old girls, 35 calories per pound. It would seem, therefore, that our children had a normal food consumption for their age, as compared with these other groups, and their height and weight records showed such progress as would indicate an adequate energy supply.

The distribution of calories among the six food groups mentioned above as compared with the proposed standards is shown in table 1.

The most conspicuous difference between the returns on this study and the standards to which they are referred, is the higher proportion of calories from the vegetable-fruit group. Among the families represented, the economic situation was not such as to demand a dietary of minimum cost. On the contrary the parents were willing to spend whatever might be necessary to give their children a

TABLE 1

Distribution of calories in percentage of total calories

FOOD GROUPS	TWO-YEAR-OLDS			THREE-YEAR-OLDS		
	Standard distribution	Nursery school		Standard distribution	Nursery school	
		Range	*Median*		*Range*	*Median*
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Foods from cereal grains	18–20	8–33	20	20–22	12–38	20
Milk	55–65	30–59	49	50–55	30–57	46
Vegetables and fruits	10–12	10–31	20	12–14	9–30	20
Fats	3–4	2–16	5	4–5	2–15	6
Sugars	1–2	0–6	2	1–3	1–12	3
Eggs and meat	3–4	0–10	4	4–5	1–13	5

*One case, a very large child, 41.5 inches tall and 47.8 pounds body weight; no other child less than 32 calories per pound.

diet advantageous for growth. A number of the children were receiving vegetables for supper rather than the more inexpensive cereal foods and fruits were eaten frequently. The habit of eating vegetables and fruits is one to be encouraged, but care needs to be taken lest it be overdone in case of very young children. There must be constant watchfulness to be sure that they are maintaining excellent digestion, with normal stools, quiet sleep and no upsets.

With the higher proportion of vegetables and fruits there would necessarily be a lowering of some other food group. Very often the vegetabes and fruits replaced cereals. The percentage of total calories from milk was somewhat lower than the standard with which it has been compared, but the median consumption was from 30 to 31 ounces, or nearly a quart per child per day, and amounted to nearly half the total calories, being 48 per cent for the two-year-olds and 46 per cent for the three-year-olds. Five two-year-olds and 12 three-year-olds received less than 40 per cent of their calories from milk but in only three cases was this percentage under 35. Even with liberal intake of vegetables, a pint of milk a day does not supply calcium for optimum storage, as shown by Sherman and Hawley (7). Children with less than 40 per cent of their calories from milk had invariably less than the median calcium intake, though they did not always fall below 1 gram per day.

The fat is only one per cent higher on the average in each group than the maximum suggested in the standard, but in individual cases it rose surprisingly high. This was due chiefly to the cod liver oil taken, a number of children having had two teaspoonfuls daily prescribed for them by private physicians and a few as much as three teaspoonfuls. No rigid adherence to a stated figure is necessary but fat in cooking is best restricted to a minimum, lest appetite and digestion suffer. The tendency among the well-to-do is to use butter, cream, olive oil, and other fats more liberally than is best for easy, rapid digestion in little children, and computing the percentage of calories from fat serves as a check on an unduly high proportion.

In practically all cases the calories in the egg and meat group represent about one egg a day, plus occasional servings of liver and more infrequently a little white fish, such as halibut, or a small portion of crisp bacon. In case of ten children the average of calories from this group was from 9 to 13 per cent of the total calories. These were under care of pediatricians who insisted upon meat for the evening meal.

Sugar is desirable mainly for making palatable the fruits and other foods used for the children's very simple desserts. In a few cases the sugar rose to a proportion which must be regarded as very unsuitable for nursery school children, due to very generous use on the breakfast cereal.

To show what kind of dietary is represented by the median distribution of calories, shown in table 1, calories were allotted to each group on the basis of the median energy intake, as indicated in table 2.

The menu and dietary (see page 37) represent selection of foods for a die-

tary for a three-year-old child on the above basis. For the two-year-olds there would be slightly smaller amounts from each group except milk. For convenience the data have been calculated in shares, the values of which are as follows: protein, 2.5 grams; calcium, 0.023 gram; phosphorus, 0.044 gram; iron, 0.5 milligram.

The actual yield of the dietaries in protein, calcium, phosphorus and iron was estimated, although calculations based on average analyses and crude measurements of food can at best be only rough approximations. On this basis, the protein intake of the children ranged from 0.9 to 2.4 grams per pound of body weight, the median for the two-year-old group being 1.6 and for the three-year-olds 1.5 grams per pound. The medians for the Merrill-Palmer Nursery School (11) group are the same, with a similar range, 0.83 to 2.69 grams. McKay (2) found an average intake of 1.3 and 1.2 grams per pound for the two and three-year-olds in her group. Roberts (4) found 31 physically superior preschool children all ingesting as much as 1.4 grams per pound of body weight. Winters (12) reports an average intake of 1.5 and 1.1 grams per pound for two-year-old boys and girls respectively, and 1.1 grams per pound for all of her three-year-olds. Since the main sources of protein in our children's dietaries are milk and eggs, insuring an amino acid assortment most advantageous for growth, and since Bartlett (1) has shown that children of these ages may be kept in positive nitrogen balance on from 0.6 to 0.9 grams of protein per pound of body weight, it is safe to say that a dietary with 46–48 per cent of its calories from milk will furnish a generous allowance of protein. Even for undernourished children, who may be able, as Wang (9) suggests, to use to advantage as much as 1.8 grams per pound, this standard will prove adequate if the total caloric intake is liberal.

The total calcium intake ranged from 0.78 to 1.5 grams per child per day, with median values of 1.13 and 1.17 grams per day for two and three year olds respectively. For optimum calcium storage Sherman and Hawley (7) recommend that one gram per day be furnished every child under fourteen years of age. They found that calcium

TABLE 2

Distribution of calories on basis of median total energy intake

FOOD GROUPS	TWO-YEAR-OLDS		THREE-YEAR-OLDS	
	Per cent of total calories	Calories per day	Per cent of total calories	Calories per day
Foods from cereal grains	20	255	20	270
Milk	49	625	46	621
Fruits and vegetables	20	255	20	270
Fats	5	63	6	81
Sugar	2	25	3	40
Eggs and meat	4	51	5	67

A Dietary Based on Median Calorie Distribution

	Calories	Calories	Per cent of total calories
Milk—31 ounces		620	46
Cereals		270	20
Wheatena—½ cup	50		
Whole wheat bread (50 per cent) 4 slices	180		
Graham crackers—2 small	40		
Vegetables and fruits		275	20
Potato—1 medium	100		
Carrots—4 tbsp.	15		
Pea puree—4 tbsp.	35		
Orange juice—4 tbsp.	25		
Prune pulp—4 tbsp.	100		
Eggs and meat—1 egg		70	5
Fats		85	6
Butter—½ tbsp.	50		
Cod liver oil—1 tsp.	35		
Sugars		35	3
Sugar—1 tsp.	17		
Karo syrup—1 tsp.	18		
Total		1,355	100

FOOD	CALORIE SHARES	PROTEIN SHARES	CALCIUM SHARES	PHOSPHORUS SHARES	IRON SHARES
Milk	6.20	11.8	46.9	18.9	4.3
Wheatena	0.50	6.1	0.3	1.3	1.4
Whole wheat bread	1.80	2.8	2.0	2.8	2.2
Graham crackers	0.40	0.6	0.2	0.9	0.8
Potato	1.00	1.1	0.7	1.6	3.1
Carrots	0.15	0.1	0.8	0.3	0.4
Pea puree	0.35	1.0	0.4	1.0	1.2
Orange juice	0.25	0.1	0.7	0.2	0.2
Prune pulp	1.00	0.3	0.8	0.8	2.0
Egg	0.70	2.5	1.4	1.9	2.9
Butter	0.50				
Cod liver oil	0.35				
Sugar	0.17				
Karo	0.18				
Total shares	13.55	26.4	54.2	29.7	18.5
Total grams		66.0	1.2	1.3	0.009

Menu Based on Preceding Plan

Breakfast

Orange juice	2 tbsp.
Wheatena	½ cup
Milk	8 oz. (for cereal and to drink)

Toast (whole wheat)	1 slice
Butter	½ tsp.
9:15	
Orange juice	2 tbsp.
Karo	1 tsp.
Cod liver oil	1 tsp.
Dinner	
Potato	1 medium
Carrots	4 tbsp.
Toast	1 slice
Butter	½ tsp.
Custard	½ cup (4 oz. milk, ½ tsp. sugar, 1 egg)
Milk	5 oz.
2:30	
Milk	6 oz.
Graham crackers	2 crackers
Supper	
Cream of pea soup	½ cup (4 oz. milk, 2 oz. pea puree)
Bread	2 slices
Butter	½ tsp.
Milk	4 oz.
Prune pulp	4 tbsp. (½ tsp. sugar)

from milk is better utilized than calcium from vegetables. There were only 3 two-year-olds who fell more than 10 per cent below this standard. These were the ones whose milk intake fell below 45 per cent of their total calories, and whose total calorie intake per pound was below the median of the group.

The total phosphorus intake ranged from 0.84 to 1.54 grams per child per day, with median values of 1.14 and 1.18 for two and three-year-olds respectively. Inasmuch as calcium is stored in the body chiefly as calcium phosphate and low phosphorus values in the blood are unfavorable to calcium deposition, the intake of phosphorus must be optimal as well as that of calcium for the best bone and tooth development. Sherman and Hawley (7) have suggested that a dietary standard of 1 gram of phosphorus per day will best meet the needs of the growing child. There were none who fell as much as 10 per cent below this standard. Since milk in amounts adequate for calcium will also furnish most of the required phosphorus, this is what would be expected from the returns on calcium.

The total iron intake ranged from 5.5 to 12.0 milligrams per child per day, with median values of 7.5 and 8.5 milligrams for the two and three-year-olds respectively. A study by Rose, Vahlteich, Robb and Bloomfield (6) of the iron balance in a nursery school child aged two and one-half years, indicated that 0.75 mg. of iron per 100 calories of food ingested would be necessary to main-

tain a positive iron balance. The actual median values of our children's dietaries are about 20 and 25 per cent respectively above an intake of 0.5 mg. per 100 calories, due chiefly to the relatively liberal use of fruits and vegetables, and daily use of eggs. A seven-months study of the hemoglobin values of the blood of these children by Platt and Freeman (3) has shown for the most part good hemoglobin production, the values ranging from 9.8 (one case) to 16.6 grams of hemoglobin per 100 cc. blood and averaging 12.6. The average for this age as given by Williamson (10) is 12.9. Since the formation of hemoglobin is easily depressed in young children, and high iron reserves are undoubtedly desirable, it would seem that effort should be made to keep the iron intake of little children high. The use of vegetables to insure an adequate supply also of copper will aid in rapid hemoglobin building. It has been shown by Vahlteich (8) that whole wheat and oatmeal as supplements to milk are very efficient in promoting hemoglobin regeneration after experimentally induced nutritional anemia, hence the use of such cereal foods is a very convenient and economical way of fostering good hemoglobin production in young children. It is especially noteworthy, in this connection, that whole wheat and oatmeal were found to be more efficient in curing nutritional anemia than corresponding amounts of iron given in the form of lean beef or liver. The daily inclusion of a portion of whole wheat bread seems to be thus well supported.

Vitamins have not been calculated in detail owing to our still limited knowledge regarding the quantities in different foods, and our lack of any experimental work on minimum requirements in children.

The need for vitamin D we believe to be met in case of the healthy child by one teaspoonful of cod liver oil daily. This furnishes at least 45 to 50 units of vitamin D. In individual cases, physicians have prescribed more, as already noted. For cure of old rickets more is always needed than for prevention of their development in a healthy, well-fed child.

The value of vitamin C, not only as a protection against scurvy and a guarantee of good health and growth, but also as a very important factor in the development and maintenance of sound, hard teeth and healthy gums, has led to the daily administration at the nursery school of a portion of orange juice (3 tablespoons) so that no child might suffer from any serious shortage of vitamin C. Three tablespoons of orange juice or tomato juice (which is really not juice alone, but the whole tomato reduced to a puree) will furnish about 20 units of vitamin C. Other fruits and vegetables should make the allowance for the day at least twice as much.

Vitamin A, indispensable for normal health, growth and resistance to various prevalent micro-organisms, is furnished daily at the nursery school to the extent of about 1000 units in 16 ounces of milk and about 800 units in 1 teaspoonful of cod liver oil. In addition 1 teaspoon of butter will yield about 100 units, an egg yolk about 825 units, a half ounce of liver about 1400 units, $\frac{1}{4}$ cup of spinach about 2300 units. One vegetable being

served regularly in addition to potatoes, it is estimated that at the nursery school each child gets daily at least 3500 to 4500 units of vitamin A. With milk, butter, and vegetables also served at home, his chance of building a reserve store of vitamin A in spite of high daily needs for growth seems to be very good.

The amount of vitamin B which can profitably be taken is undoubtedly more than will suffice to attain a normal rate of growth. For the best appetite and digestion a quantity many times the growth requirement seems to be desirable. The nursery school diet guarantees daily at least 200 units. Of these approximately 144 units are estimated to have come from 16 ounces of milk, 14 units from 3 tablespoons of orange juice, 24 units from an egg yolk, 25 units from one slice of whole wheat bread, at least 15 units from a small serving of potato. With another vegetable besides potato at noon and an equally good dietary at home, there would seem to be an adequate supply of

TABLE 3

Summary of findings in dietary studies of 163 nursery school children

	TOTAL RANGE		25TH–75TH PERCENTILE		MEDIAN	
	2 year olds	3 year olds	2 year olds	3 year olds	2 year olds	3 year olds
Age, months	18–30	31 –42	21–27	34–39	24	37
Height, inches	31–39½	33½–43½	33–35	36–39	34	37½
Weight, pounds	22–35	26 –47	26–30	31–35	28	33
Total calories	1,000–1,575	950–1,650	1,150–1,325	1,250–1,450	1,275	1,350
Calories per lb.	36–55	29–50	41–47	38–44	44	41
Calorie distribution in percentage of total calories:						
Cereals	8–33	12–38	16–24	17–23	20	19
Milk	36–59	30–57	42–53	43–49	48	46
Fruits and vegetables	10–31	9–30	16–21	16–22	18	19
Fats	2–16	2–15	4–7	5–8	5	6
Sugar	0–6	1–12	1–3	2–4	2	3
Eggs and meat	0–10	1–13	3–5	3–7	4	5
Total protein, grams	35–71	38–71	42–50	45–53	46	50
Protein per lb., grams	1.2–2.3	0.9–2.3	1.4–1.8	1.3–1.6	1.6	1.5
Total calcium, shares	38–64	34–65	45–54	48–56	49	51
Total calcium, grams	0.87–1.47	0.78–1.50	1.04–1.24	1.10–1.29	1.13	1.17
Total phosphorus, shares	20–33	19–35	24–28	25–30	26	27
Total phosphorus, grams	0.88–1.45	0.84–1.54	1.06–1.23	1.10–1.32	1.14	1.18
Total iron, shares	11–24	11–23	13–17	14–19	15	17
Total iron, grams	0.055–0.120	0.055–0.115	0.065–0.085	0.070–0.095	0.075	0.085

vitamin B for children with good appetites and normal calorie intake. More recently a few children with poor appetites have received additional vitamin B in their orange or tomato juice, with decided benefit. We are inclined to think that children getting over 5 or 6 per cent of their total calories from sugar, over 10 per cent from fat, 35 to 40 per cent from white cereals and white bread, and less than 40 per cent from milk, are not likely to have enough vitamin B for best health.

Vitamin G has been so recently differentiated that we know less of relative requirement for this than for the vitamins already mentioned although we know it to be essential for good appetite and good growth. Milk, eggs, and liver are rich sources. Among vegetables, tomato, carrot, yellow turnip, spinach and collard greens appear to be excellent.

SUMMARY

A study has been made of the distribution of the calories contributed to the dietary by six food groups (1) Food from cereal grains, (2) Milk, (3) Fruits and vegetables, (4) Fats and oils, (5) Sugars, (6) Eggs and meats. This included 163 children from eighteen to forty-two months of age. The children received approximately half the day's total calories at the nursery school, and suggestions were made to the parents as to the best meals for the home to make the total food intake for the day satisfactory.

Children whose food intake showed a distribution of calories approximating the median value for each group had an excellent dietary, adequate in protein, calcium, phosphorus and vitamins, although not as high in iron and vitamin B as may on further investigation prove to be desirable. Children with less than 40 per cent of their total calories from milk did not have an optimal intake of calcium and sometimes not of phosphorus. Those with low milk tended to higher sugar and meat, foods which are deficient in growth promoting properties. The intake of fruits and vegetables is greater than a standard fomerly proposed for diets of low cost. It would seem from the study just made that over 15 per cent of the calories of these young children's diets may well come from carefully selected and prepared fruits and vegetables which will increase the intake of vitamins B and C and of iron. To provide for the regular daily addition of cod liver oil for the sake of its rich supply of vitamins A and D, a somewhat higher allowance of fat seems desirable. A new standard distribution for nursery school children is therefore suggested, as follows:

		Per cent of total calories
I.	Foods from cereal grains	18–20
II.	Milk	45–55
III.	Fruits and vegetables	16–22
IV.	Fats and oils	4–8
V.	Sugars	1–3
VI.	Eggs and meats	3–5

The data are summarized in table 3.

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A Two Year Record of Attendance and Colds in a Nursery School

Herbert S. Conrad and Mary Cover Jones[1]

THE present study has grown from the collection of data, over a two-year period, on the attendance of children in a nursery school. The data show that a large percentage of absences are attributable to "colds." A statistical analysis indicates that these "colds" are probably infectious. The high incidence of colds, plus their infectious character, make this ailment one of the most important with which the modern nursery school must contend.

THE SAMPLE

The sample consists principally of the children enrolled in the nursery school of the Institute of Child Welfare, University of California. For confirmatory data on certain points, records of the children in the Children's Community (a cooperative nursery school in Berkeley) are also employed. Both of these schools draw nearly all their children from homes of superior economic and social status. The average enrollments and ages of the children in the two schools are presented in tables 1 and 2.

THE DATA

Full records of attendance are kept at the Nursery School of the Institute of Child Welfare. Children are examined daily as they enter the school by the Institute pediatrician, a nurse, or a member of the Nursery School staff. If there is evidence of a cold or other communicable disease (such as reddened throat, swollen lymph glands, or running nose), the child is sent home. If symptoms develop during the school day, the child is isolated until he can be called for. A child taken home before 10:30 a.m. is marked as absent; a child taken home later than 10:30 a.m. is marked as present. In the case of children kept at home by their parents, a telephone call on the first day of absence, and at intervals during the period of absence, serves as a check on the attendance records. The causes of absence are recorded daily under the headings: "Cold," "other illness," and "other causes." With the exception of colds, there have been no epidemics at the school.

At the Children's Community, the

[1] We wish to express our appreciation to Mrs. Pearl B. Crawford in the Institute of Child Welfare, and Mrs. P. S. Taylor, of the Children's Community, for the use of their records of attendance; to Miss Lina Hutson, for assistance in the statistical work; and to Dr. Harold E. Jones, Director of Research at the Institute of Child Welfare, for his careful criticism of the manuscript.

daily inspection of children for evidence of communicable diseases is made by a public health nurse. The records at the Children's Community, however, are not so complete as at the Institute school. For this reason, all absences at the Children's Community have in this paper been treated alike, no attempt being made to distinguish between absence due to colds or other causes.

TABLE 1

Age of children, and enrollment: Nursery School of the Institute of Child Welfare

DATES	AVERAGE ENROLLMENT	AVERAGE AGE OF CHILDREN AT BEGINNING OF SCHOOL TERM	RANGE OF AGES OF CHILDREN AT BEGINNING OF SCHOOL TERM
		months	*months*
October 10, 1927 to December 23, 1927*	20.9	28.2	21–38
January 9, 1928 to May 29, 1928*	25.0	33.4	20–48
August 20, 1928 to December 14, 1928*	27.6	38.4	24–55
January 7, 1929 to May 29, 1929**	24.7	32.1	19–50

* In session from 9:00 a.m. to 4:00 p.m., including a lunch-and-nap period averaging 3 to 3½ hours.

** In session from 9:00 a.m. to 1:00 p.m., including lunch.

TABLE 2

Age of children, and enrollment: The Children's Community

DATES	AVERAGE ENROLLMENT	AVERAGE AGE OF CHILDREN AT BEGINNING OF SCHOOL TERM	RANGE OF AGES OF CHILDREN AT BEGINNING OF SCHOOL TERM
		months	*months*
August 13, 1928 to December 14, 1928*	21.4	44.7	27–65
January 7, 1929 to May 31, 1929*	21.9	43.8	30–55

* In session from 9:00 a.m. to 1:00 p.m., including lunch.

RESULTS

Table 3 gives the per cent absent each term in the Institute school. The high per cent of absences (34.5) accords strikingly with that found in other nursery school groups—32.4 by Anderson (1) at Minneapolis, and 34.1 by Bott (2) at Toronto. Of the absences in these other schools, from about one-half to three-fourths were stated as due to colds; in the nursery school of the Institute of Child Welfare at Berkeley, about two-thirds of the absences were due to colds (the correlation between the per cent absent due to colds and the total per cent absent is, for a 325-day period at the Institute school, .87), and only one-eighth were due to other illnesses.

At the Children's Community, the percentage of absence is somewhat lower, averaging 26.6 per cent (table 4). At least part of this lower per cent is due to the fact that several

mothers officially withdrew their children during a long illness, and reentered them when they were fully recovered. Since these children are excluded from the computation during the period when they are withdrawn, the per cent absent is of course lowered. A further probable factor is the greater average age of the enrollment at the Children's Community (cf. tables 1 and 2).

TABLE 3

Percentage absent: Nursery School of the Institute of Child Welfare

PERIOD	POSSIBLE ATTENDANCE (PUPIL-DAYS)	ABSENCES			
		Due to colds	Due to other illnesses	Due to other causes	Total absence
		per cent	*per cent*	*per cent*	*per cent*
October 10, 1927 to December 23, 1927	1,106	19.6	3.4	5.2	28.2
January 9, 1928 to May 29, 1928	2,402	26.1	6.8	8.7	41.5
Total period	3,508	24.0	5.8	7.6	37.3
August 20, 1928 to December 14, 1928	2,204	21.6	4.3	4.8	30.6
January 7, 1929 to May 29, 1929	2,372	24.4	3.2	6.2	33.8
Total period	4,576	23.0	3.7	5.5	32.3
Total for 2-year period	8,084	23.5	4.6	6.4	34.5

TABLE 4

Percentage absent: The Children's Community

PERIOD	POSSIBLE ATTENDANCE (PUPIL-DAYS)	TOTAL ABSENCES (PUPIL-DAYS)
		per cent
August 13, 1928 to December 14, 1928	1,822	24.5
January 7, 1929 to May 31, 1929	2,100	28.4
Total period	3,922	26.6

Statistical analysis of the high per cent of absence due to colds: cycles, trends, and the effect of vacations

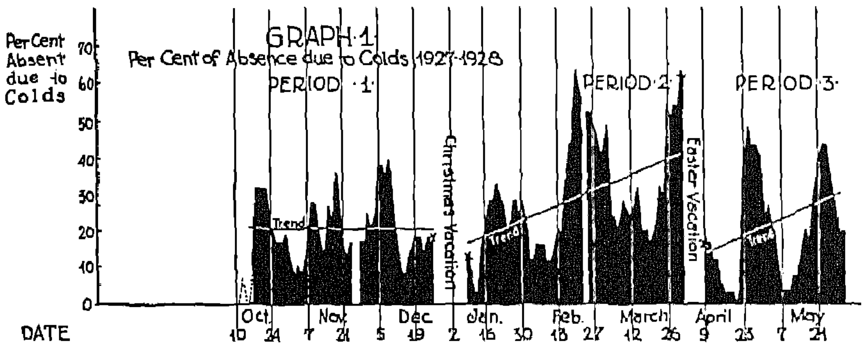
The high frequency of colds among nursery school children indicated in tables 3 and 4, and in the reports of other investigators, challenges further analysis. In the present paper we are particularly concerned to discover if the high incidence of colds can in any way be attributed to the nursery school itself—whether through overstimulation and fatigue of the children, or through group-infection.

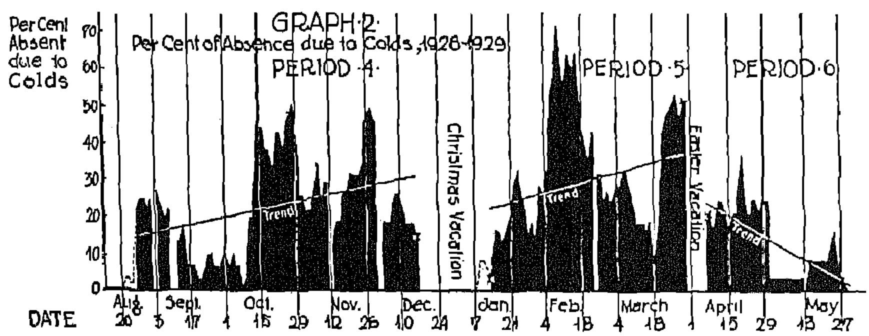
In Graphs 1 and 2 we present, for each school day in a two-year period, the percentage of children absent because of colds. Particular attention is called to the cyclical character of the curves—especially clear in Periods II, III, and V. If the reader will visually *connect* the various periods (e.g., II

and III), the impression of cyclical character is confirmed.

We assume that the cycles of per cent absent due to colds, are caused by cycles of fresh colds. A possible alternative explanation, however, is that the incidence-rate of colds among nursery school children remains more or less constant: it is the time required for recovery and return to the nursery school, that varies cyclically. This latter explanation obviously lacks the plausibility of the theory of cycles of incidence. Possibly, of course, both the rate of incidence and the rate of recovery vary cyclically, the one more or less independently of the other. So long, however, as it is admitted that the cycles in Graphs 1 and 2 are at least partially caused by cycles in the incidence of fresh colds, the argument in the subsequent pages of this article will remain valid.

With our present data we have not attempted to plot the incidence of *fresh* colds for each day of the two-year period, because in the case of a rapidly recurring condition (such as a "cold" among nursery school children), it becomes rather difficult to distinguish between what is a fresh condition, a relapse, or a continuation.





The trend-lines inserted in Graphs 1 and 2 have been fitted by the method of least squares. The trend-lines were obtained from the correlation between *time* (including Saturdays and Sundays) and *per cent absent due to colds.* In obtaining the correlations we omitted the data for the week of October 10–14, 1927; and for the weeks of August 20–24, 1928, and January 7–11, 1929. These are initial weeks of the school term, during which a considerable number of new children were admitted. The new children probably presented an abnormally low per cent of colds during the first week, since the mothers would not be likely to bring them to the school if they

were at all ill. We believed, upon the advice of the Institute pediatrician, that a week was long enough for the incidence of colds among the total enrollment again to become normal and typical. In four instances out of six, the trend is definitely upward—meaning that on the average, in the school-periods between vacations, the per cent of colds increases.

sure, indoor temperature, outdoor temperature, and relative humidity, failed to assign a definite causative influence to any of these factors. This is in accord with Anderson's report from the Institute of Child Welfare at the University of Minnesota, that for a seven-month period from November to May, extremes of temperature, wind, and sunshine are uncorrelated

TABLE 5

Decrease in absence following "long" vacations

DECREASE IN THE PER CENT OF ABSENCE DUE TO COLDS, FROM	AMOUNT OF DECREASE
	per cent
December 23, 1927 to January 9, 1928	5.2
March 30, 1928 to April 9, 1928	45.5
December 14, 1928 to January 14, 1929	11.4
March 28, 1929 to April 8, 1929	31.2
Average drop following a vacation*	19.6 ±.035†

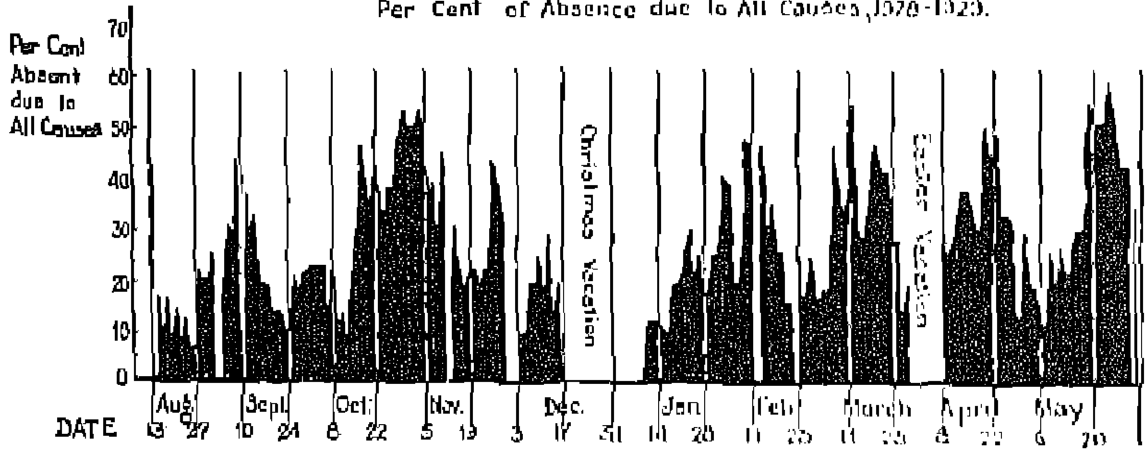
* Weighted average, the weights being inversely proportional to the squares of the P.E.'s of the individual decreases. (The unweighted average is 23.3 per cent.)

† P.E. computed according to the formula recommended in reference (4). The true P.E., however, is lower than .035. For in the first place, a correlation undoubtedly exists between the per cent absent on the two dates compared (viz., the pre-vacation and post-vacation days); but this correlation can hardly be computed from our data, and was for this reason ignored in the formula for computing the P.E. In the second place, what is really wanted is the P.E. of the difference between the *levels around* the two dates compared. The reliability of this difference between levels would undoubtedly be greater than the reliability of the difference between the per cents absent on two calendar dates; but the reliability of the difference between levels has not been computed by us, in order not to complicate the statistical presentation.

The question arises at once as to whether these upward trends are due to the fact that the school periods coincide with calendar periods during which an average rise in colds in normal—due, that is, to seasonal conditions. What evidence we have, however, tends to minimize the importance of season and weather. In the first place, a preliminary investigation at the Institute for the period January-May 1928, of barometric pressure, indoor temperature, outdoor temperature, and relative humidity, failed to assign a definite causative influence to any of these factors. This is in accord with Anderson's report from the Institute of Child Welfare at the University of Minnesota, that for a seven-month period from November to May, extremes of temperature, wind, and sunshine are uncorrelated with nursery-school attendance (1). In the second place, the curves in Graphs 1 and 2 do not (except in February) point to any very uniform seasonal factor. Thus, in the period following the Eastern vacation, colds *increase* in 1928, but decrease in 1929. These two periods after the Easter vacation are rather short; and in short periods there is danger that a trend may be unduly influenced by an incomplete cyclical movement (i.e., by a

half-wave). Inspection of the graphs indicates that this theoretical source of invalidity possibly affects the downward trend in Period VI, but not the upward trend of Period III. Similarly, in the initial period of the school year, colds remain *constant* (on the average) in 1927, but *increase* in 1928. This is again in accord with Anderson's report that "there is very little variation in the attendance [of nursery school children] from month to month (1)." In the third place, the percentage of absence due to colds drops after each vacation of a week or longer, *regardless* of the season. The exact amount of decrease is given in table 5. The average decrease of 20 per cent following a vacation is sufficiently striking to make comment unnecessary. The statistical details are given in the footnote to the table.

GRAPH 3
The Children's Community
Per Cent of Absence due to All Causes, 1928-1929.



In Graph 3 we present, for the Children's Community, the per cent absent (due to all causes) in the period August 13, 1928 to May 27, 1929. This graph resembles the two already discussed for the Institute school, supporting the inferences derived from them. It is, however, somewhat more irregular, doubtless due to the heterogeneity of the causes of absence. Probably for the same reason, too, the presence of cycles of absence is less noticeable, and the effect of vacations is not uniform.

Further analysis of results: the weekly trend, and the effect of brief vacations

In the previous section it was noticed that colds tend to increase during a school period. We have been concerned to allocate this rise exactly. Does the rise take place chiefly between Friday and Monday, when the children are not in the nursery school? or does the rise occur mainly between Monday and Friday? The data necessary to answer these questions is contained in Graphs 1–2. In these graphs, all alternate Mondays have been labeled with their appropriate calendar date; thus, in Graph 1, Oct. 10 and 24 are alternate Mondays; the intermediate Monday, Oct. 17, is unlabeled.

Statistical reduction of the data in Graphs 1 and 2 with the omissions previously mentioned shows that for the two-year period in the Institute school, the average rise in colds from Monday to Friday is 3.5 per cent.

This average weekly rise is based on the regression line of Y on X—where X is the day of the week (Monday through Friday); and Y is the algebraic increase in the per cent of colds from Monday to the successive days of the week. The average rises from Monday to Tuesday, Monday to Wednesday, Monday to Thursday, and Monday to Friday are .93, .71, 2.39, and 3.13 per cent, respectively. These raw figures must not be confused with those derived by curve-fitting (i.e., use of the regression line of Y on X). The Pearson correlation between day-of-week and change in per cent absent due to colds is + .136 (n = 298); no reliable curvilinearity of regression was observed. It is clear that the cyclic character of the incidence of colds (see Graphs 1 and 2) seriously (and for our purposes, spuriously) diminishes the magnitude of the *correlation coefficient*, thus depriving it of much of its usual significance. This is much less true, however, of the *regression line*, from which the average weekly rise of 3.5 per cent was computed.

Anderson (1) reports no relation between the day of the week and the per cent attending that day at the Institute of Child Welfare of the University of Minnesota. Anderson's period of investigation was somewhat shorter than ours (covering 112 schooldays between November 12, 1925 and May 14, 1926).

The school régime does not appear to exert any clear influence on the average weekly rise. As a matter of fact, the greatest average weekly rise (7.8 per cent) occurs in the term January 14, 1929–May 29, 1929 (Periods V and VI, Graph 2); during this term the school hours were the shortest, offering the least opportunity for tiring through over-stimulation. In all except the last term (Periods V–VI), when the children were sent home at 1:00 p.m., the nursery-school routine included a long midday nap. If the mothers failed systematically to continue this program, this might account at least in part for the exceptionally high weekly rise in this period.

Along with the average weekly rise in the per cent absent due to colds, there occur more or less regular drops. These drops come, on the average, after vacations—especially after the relatively long, regular vacations, labeled as such in Graphs 1 and 2; but also after the irregular, brief vacations (such as Thanksgiving recess) indicated by breaks in the graphs; and after the regular Friday-to-Monday vacation (not shown in Graphs 1 and 2). The average drop in absence-due-to-colds following any brief vacation extending up to Monday (or to later in the week) and including the regular Friday-to-Monday interval when the children are not attending school is 3.2 per cent ± 1.06. This is the P.E. of the actual distribution of differences between the days compared (viz., the pre-vacation and the post-vacation day). For the Friday-to-Monday vacations exclusively, the average drop is 1.95 ± 1.09. For simplicity we here discuss this last figure only. The actual drop of 1.95 per cent fails to do the Friday-to-Monday vacation full justice. On the basis of the average 3.5 per cent rise

from Monday to Friday, one would expect a *continuation* of this rise from Friday to Monday. The precise amount of rise from Friday to Monday which we should expect, on the basis of the regression of Y on X is 2.6 per cent. Instead of this theoretical *rise*, however, we actually observe an average *drop* of 1.95 per cent,—making the *net* decrease due to the Friday-Monday vacation equal to 4.55 per cent.

Although other explanations suggest themselves, it is most harmonious with the indications of the data previously presented, to suppose that both the average weekly rise in absence and the drop after brief vacations are caused by the infectious nature of colds in the nursery school group.

One alternative explanation assumes that if a child has contracted a cold in the early part of the week, the mother (out of caution, or solicitude, or mere inertia) will fail to return the child to the nursery school until the beginning of the next week; whereas, had the child become well in the earlier part of the week, the mother would be more prompt in returning the child to nursery school. We are, in general, inclined to reject this explanation, because of such facts as the following: the mothers are eager to send their children to the nursery school; keeping a child at home often requires special arrangements; too often, mothers (on all days of the week) have been seen to wipe the noses of their children before morning inspection, possibly with intention to evade detection of the infectious condition; and finally, mothers very commonly attempted to return their children to the nursery school before the cold was (according to our standards) completely cured.

Another explanation of the Friday-to-Monday drop emphasizes the possibility of infection of the nursery school children by parents or siblings at home: the theory being that parents and siblings constitute a cumulatively increasing source of infection to the nursery school children during the week; whereas, over the week-end, these older members are themselves less exposed to colds, and consequently do not to the same extent disseminate infection. This theory seems to us improbable. For relatively few of the nursery school children have elder siblings; and it is not at all clear that such older siblings or the adult members of a household, would be less exposed over the week-end than during the week. Further, the theory would require that after a long vacation (involving increased home contact), an increase in absence due to colds should occur; whereas a decrease is actually observed (table 5).

The influence of age

Before formally presenting our interpretation of the long-time and short-time trends and cycles noted in the preceding sections, it may be well to clear from the field the possibly disturbing factor of chronological age. Do the very young children in the nursery school present a different picture from that of the older children? To answer this question we prepared a graph of the per cent absent due to colds among (a) the younger half of the nursery school children and (b) the older half. Examination of this graph reveals no important consistent difference between the two groups; except that the percentage of absence among the younger children appears occasionally to rise to higher peaks than among the older children. These facts agree with those of Anderson (1), who reports that "there is a slight but hardly significant tendency toward greater attendance among the older children," and that "there is greater variation in the attendance of the younger than there is among the older children." On the whole, in the age range considered, the differences between our younger and older groups are sufficiently slight to justify our treatment of the nursery school group as a unit regardless of age.

INTERPRETATIONS

The principal facts presented above are:

1. The high percentage of absence due to colds (tables 1 and 2).

2. The cyclical character of the incidence of colds (Graphs 1 and 2).

3. The upward trend (on the average) of the incidence of colds in the school periods between regular vacations (Graphs 1 and 2).

4. The rise in colds (on the average) from Monday to Friday.

5. The average drop in the per cent absent-due-to-colds after the "long" vacations (table 5).

6. The average drop in the per cent absent-due-to-colds after brief vacations, and even after the regular, weekly Friday-to-Monday vacation.

Although most of the above facts could probably be used by partisans of any one of the current theories concerning the causes of colds, the cyclical character of the incidence of colds would seem to accord best with the supposition that colds are infectious. If the absences due to colds were caused solely by over-stimulation and fatigue of the children by the nursery school regime, one might expect the high percentage of colds; one might perhaps expect the rise in colds during the week; and one might expect the drop in the percentage of colds after vacations. But one would hardly expect, and one could hardly explain the cyclical character of the incidence of colds. To explain this cyclical character, weather conditions appear insufficient (*vide supra*); and the same may be said for the suggestion of possible dietetic factors. Dr. Volney S. Cheyney's theory is that colds are caused by "a mild acidosis" . . . . "an altered metabolism and a systemic disturbance affecting all the fluids and secretions of the body" (3). Although fully accepting the importance of a proper acid-base equilibrium for the maintenance of health and resistance, and even conceding the possibility of a specific pathological effect of acidosis, we still find it very difficult to see why altered metabolism or acidosis as a cause of colds should occur in the particular cyclical form manifested in Graphs 1, 2, and 3.

The most plausible explanation for the cyclic (as well as all the other) characteristics of the incidence of colds appears to be the theory of group-infection.

This statistical analysis of colds in two nursery schools is not quite complete without reference to a control group composed of children of similar characteristics, who are not in nursery schools. Steps are being taken to provide such a group. In the meantime it may be noted that the children attending both the Institute School and the Community School, come from various parts of the city of Berkeley. The influence of any purely local factor of morbidity (other than attendance at the same nursery schools) seems for this reason sufficiently excluded.

All the published data on the attendance of children in nursery schools demonstrate beyond a doubt that the largest proportion of absence is due to "colds." Even if these colds caused no physiological injury whatever, there is little question that the disturbance of routine, and the pampering customarily bestowed on ailing children, is likely to cause significant psychological damage. Nursery schools would do well, therefore, to invite and promote

active research on the common cold. In the field of practical diagnosis, especially, nursery-school facilities would appear to be well suited for an intensive research program.

Meanwhile, in the absence of more specific information, the following practical measures for the prevention of group-infection in the nursery school are suggested: division of the total group into smaller, non-communicating units; rigid inspection of all children each morning upon entrance, and perhaps also at some other time in the school day; and routine disinfection of all common toys and play materials.

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A Technique for Diary Analysis[1]

Esther L. Belcher

Diary recording is one of the oldest methods of studying the behavior of children. The relative advantages and disadvantages of such records as compared to those secured by more systematic types of observation have been subjects for considerable discussion. Special merit is frequently claimed for the inclusive nature of diary observations. On the other hand, the systematic methods of observation of delimited types of behavior lend themselves more readily to control of the observer and to quantitative treatment and interpretation. The widespread use of diary methods necessitates some inquiry into the reliability of the data collected and into the uses which may be made of the results.

In the course of a study of the adjustment of a group of nursery school children to a public school kindergarten, the writer made a series of six observations from eight-thirty to nine-thirty o'clock each morning in each of two schools. All children were observed simultaneously. The writer's object was to secure a complete protocol of the teacher-child relationship, with no selective attention to any particular activity. The record consisted of a running account of events made in longhand in a notebook.

No plan for the treatment of the data was formulated in advance. Subsequent to making the observations, it was believed to be of interest to determine whether some of the principles evolved from time-sampling techniques could be applied in analyzing diary records. The method of analysis was suggested by Olson (3). The application of such a method to an analysis of data already secured in diary form has, of course, obvious limitations as compared to that of employing the time-sampling technique originally, i.e., in both the recording of observations and the study of results.

For the analysis of the diary account, a unit of measurement was defined in general as any manifestation of a specific item or category of behavior by a child during an observation sixty minutes in length. Two large categories were established, subdivided as follows:

1. Teacher-initiated activities
   - a. Teacher gives *aid* to child. (Includes unsolicited physical or verbal help.)
   - b. Teacher initiates *conversation* with child. (Includes "give and take" in remarks on general matters.)

[1] From the Child Development Laboratories of the University Elementary School, University of Michigan.

c. Teacher *criticizes* social or emotional behavior of child or use of materials.
d. Teacher gives definite *suggestion* to a child. (As in calling attention to routine.)
e. Teacher settles a *group conflict* among children.
f. Teacher gives *stimulation* to guide child in making a choice.

2. Child-initiated activities
   a. The child asks for *aid*.
   b. The child starts a *conversation* with a teacher.
   c. The child *volunteers* some information.
   d. The child asks a direct *question* of the teacher.

In order to use material of this type in an analysis of teacher-child or child-teacher contacts, we would wish to know something concerning (1) the completeness of the notes taken, (2) the constancy and reliability of group and individual records, and (3) the number of time samples needed to get dependable descriptions of the behavior patterns of individual children. A statistical analysis of the diary in the described units yields some information on the last two problems.

By employing the defined categories, it became possible to go through the diary record and secure a frequency count for the various items (table 1). In the assignment of behavior to categories, there is probably a subjective factor which could be

TABLE 1

*Frequency count of each trait studied**

	SCHOOL A			SCHOOL B			SUMMARY		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Teacher-initiated activities:									
Direction	28	39	67	22	13	35	50	52	102
Conversation	26	26	52	6	8	14	32	34	66
Criticism	13	14	27	19	13	32	32	27	60
Aid to child	20	18	38	13	7	20	33	25	58
Stimulation	27	16	43	1	2	3	28	18	46
Group conflict	8		8	4		4	12		12
Total	122	213	235	65	43	108	187	156	343
Child-initiated activities:									
Child asks aid	19	19	38	13	9	22	32	28	60
Questions	7	11	18	3	2	5	10	13	23
Volunteers	4	6	10	2	1	3	6	7	13
Conversation	5	1	6		1	1	5	2	7
Total	35	37	72	18	13	31	53	50	103
Number of children	13	19	32	15	12	27	28	31	59

* The maximum possible occurrence in each sub-classification under the conditions of the method is the number of children as shown in the last row of the table multiplied by six (the number of observations).

tested by having a second person study the records in a similar fashion. Such a check was made by Andrus (1). It will be noted that the rank order of behavior items is roughly similar for boys and girls, and similar trends

TABLE 2

Coefficients of correlation between consecutive observations of teacher-initiated activities when analysis is made in terms of the subdivisions of the larger category

OBSER-VATION PERIOD	SCHOOL A					SCHOOL B				
	Direction	Conver-sation	Criti-cism	Aid to child	Stimu-lation	Direc-tion	Conver-sation	Criti-cism	Aid to child	Stimu-lation
1–2	.44	−.21	−.14	−.09	.00	.02	.00	.30	.52	.00
2–3	.04	.24	−.14	.25	.00	.32	−.13	.20	−.15	.00
3–4	−.09	.12	.60	.01	.11	.88	.04	.73	.20	.00
4–5	.37	.44	.83	−.15	.38	.80	.04	.72	.38	.00
5–6	.48	.03	.30	.16	.40	.89	−.09	.60	.54	.00

are maintained when the data are studied separately by schools. Consequently, there seems to be a basis for the prediction of group trends

TABLE 3

Coefficients of correlation between consecutive observations of teacher-child and child-teacher contacts when the data are analyzed in terms of the major categories

OBSER-VATION PERIODS COM-PARED	SCHOOL A		SCHOOL B	
	Teacher-child	Child-teacher	Teacher-child	Child-teacher
1–2	.41	−.08	.41	.61
2–3	.23	.45	.33	.21
3–4	−.08	.10	.77	−.01
4–5	.31	.47	.67	−.09
5–6	.74	.24	.67	.73

that can be revealed by the method. No attempt will be made here to present an analytic study of the facts of table 1. Perhaps the most obvious trend is the preponderance of teacher-initiated contacts in the total number of contacts.

The extent to which a single observation period will give reliable descriptions for individual children with respect to behavior in these categories can be studied by comparing the observations of one period with that of another. This is accomplished by setting up four-fold tables showing presence and absence of the behavior on each occasion for each child. When

TABLE 4

Reliability coefficients for teacher-initiated activities

BEHAVIOR	SCHOOL A		SCHOOL B	
	r Odd-even	Spear-man-Brown predic-tion	r Odd-even	Spear-man-Brown predic-tion
Direction	.78	.87	.51	.67
Conversation	.26	.41	.57	.74
Criticism	.76	.86	.62	.77
Aid to child	.02	.04	.58	.73
Stimulation	.48	.65	−.01	

this is done for consecutive observations in the subdivisions of the teacher-initiated activities, it will be noted (table 2) that the coefficients (the method used is described by Kelly (2)) show considerable variability with a range from comparatively

high positive correlations to some correlations which are actually negative. More often than not, however, the coefficients seem to be positive and show that there is some consistency involved. In the material given, it would be difficult to isolate the effects of constancy of the behavior and reliability of the recording. It is fairly safe to assume, however, that a single diary record of the activities of a group of children may be quite erroneous in describing the behavior of an individual child within it. The situation appears to be improved somewhat if we are willing to limit our description to coarser categories (table 3). Smith (4) arrives at the same conclusion in a recent report in which a running account of a child's behavior has been made and analyzed in accordance with a modified form of time sampling measurement.

The advantage pointed out in connection with current studies to the effect that multiplication of observations employing a definite unit of behavior of a stated length of time results in increased reliabilities can be illustrated with the diary data. A score was computed for each child, based on the number of one-hour observation periods in which a particular category of behavior was shown. When the odd-numbered observations are compared with the even-numbered observations, it will be observed that negative correlations tend to disappear and appreciable correlations appear (table 4).

The claims for the value of diaries in synthetic interpretations of complex behavior patterns has not been touched upon. It should be noted that interrelationships within the diary record can be studied quantitatively by the same correlational methods as were used in the study of reliability, although the scientific value of the determinations may be lower than in systematic recording.

CONCLUSIONS

It would appear from the present analysis that diary recording of observations can yield usable data when we are interested in coarse units of behavior or trends within a group, and that diaries take on an increasing reliability for individual description as the diary records are multiplied. It is believed that diaries may also serve an exploratory use to suggest subsequent delimitations of behavior for an attack by the method of repeated short samples employing carefully defined categories.

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The Form and Function of Children's Questions

Edith A. Davis

STATEMENT OF THE PROBLEM AND SUMMARY OF PREVIOUS INVESTIGATIONS

THE literature on child development nowhere yields an analysis of unselected spontaneous questions asked by a large number of children in the every-day home situation. This is surprising in view of the fact that we find interest in the subject ranging all the way from the genetic approach of Darwin (7), Taine (28), and others (15, 16, 22, 25) to the recent functional classification of Piaget (21). To Bain (1), Compayre (6), Sully (27), and Bohannon (2) the asking of questions is due to the instinct of curiosity. Woodworth (34) points out that the driving force is "curiosity regarding some particular thing." To Bohannon (2) inquisitiveness and curiosity express "defective self-control," or in Sully's (27) words "a mood of general mental discontent and peevishness." Hall and Smith (11) made a pioneer analysis of questions in connection with a study of curiosity in its relation to interest. Out of 1247 questionnaire descriptions of cases of curiosity, 477 were questions, but since they were reported from memory they could hardly be accurate in form or representative in content. The authors suggest that "a list of all the questions asked by a child during a week or a month would probably furnish material for a very fair guess at his interests and surroundings."

Some information as to frequency of questions may be obtained from the conversation records of the pioneer students of language development. Boyd (4) found that questions constituted 21.6 per cent of the 1250 remarks made by his daughter which he recorded annually from her second to her eighth birthday. Trettien (29) recorded 49 questions in one hour's observation, 22 per cent of the total conversation during the hour. The Brandenburgs (5) classified 18 per cent of their child's conversation as questions at thirty-eight months, 20 per cent at fifty-two months. The conversation of the two six-year-old boys studied by Piaget (21) yielded 17 and 13 per cent of questions. Nice (18) reports the lowest percentage found by any of these investigators, 11.2 per cent in the conversation of a forty-seven months old girl during a thirteen hour day.

The normative language studies of Smith (23) and McCarthy (17) throw further light on this point. They are of especial value since they deal with groups of children at successive age levels, instead of being confined to one or two individuals. Both these studies find that the percentage of questions

increased with age up to about five years, when the investigations were concluded. McCarthy's results, obtained from children carefully selected for age, sex and, socio-economic status, seem conclusive. Between the ages of thirty-six and fifty-four months, questions made up 14.4 per cent of the conversation of children in the upper socio-economic classes, 7 per cent of that of children in the lower socio-economic classes.

There has been much speculation as to the function of questioning in child development. Sully (27) finds two categories: (1) thirst for fact (what, how old, where, who, naming); (2) reason and cause (why), beginning at two, but most frequent from three to four years. The motivation may be "desire for order and connectedness" leading to anthropomorphism; teleological (cause, purpose); and a deeper "sense of perplexity, mystery, contradiction." Trettien (29) finds reason and cause linked with the anthropomorphic attitude and following the simpler questions of "fact, substance, action, place." Snyder (24) differentiated four categories, of which that begun by the interrogative words is last to appear and most complex. Her others are variations of the imperative, involving coöperation, permission, or approbation; questions of fact (counterpart of declaration); and a combination of question and exclamation.

Smith (23) adapted the Snyder classification, including requests for permission, approbation, or corroboration as a fifth category. Stern (25) describes two ages of questions, the naming period, reached in the second half of the second year, and the three to four year stage of when and why, directed mainly toward justification of commands and the desire to know. Hollingworth (12) places the Questioning Age from three to six and classifies the motivation as first, genuine curiosity; second, the desire to check up the child's own generalizations by the approval of one better informed; and third, getting and holding the attention of others. Piaget (21) has developed the most complete classification of questions to date, and reported it in such detail that it could be used in the present study. A teacher recorded 1125 of the spontaneous questions of a six year old boy on daily walks of about two hours extending over a ten months period. Unfortunately she began by recording only *Whys*, and midway changed her procedure so as to include all questions, thus making it impossible to calculate percentages for the various categories.

METHOD

The questions analyzed in this study were recorded by mothers attending study groups conducted by the Parental Education Department of the Institute of Child Welfare at the University of Minnesota. They were provided with blanks adequate for recording 50 questions, together with the explanatory data concerning time of day, person questioned, and similar information needed to make the questions intelligible. An instruction sheet was furnished with the blanks. Mothers were requested to start the record in the morning and as far as possible to continue without a break,

including everything of interrogative form except single word questions, which would often be so obscure in meaning as to make classification impossible. Periods such as nap, school, or outdoor play during which the child was not under the mother's observation, were to be omitted. Meaning was to be clarified by parenthetical explanation and underlining the emphasized word. Mothers were cautioned against polishing up the child's language, or attempting to elicit questions. The instructions were closely observed, and the records were carefully and very satisfactorily filled out.*

No attempt was made to control age, sex, or socio-economic status, save that the age limits were roughly set as three and twelve years.

Blanks were returned only by mothers belonging to the three upper socio-economic categories. It seems probable that such factors as interest in the study of children, leisure to indulge this interest, and the ability to fill out a fairly complicated blank, would necessarily operate to select a superior group of mothers. This situation made it impossible to verify the findings of other investigators (8, 10, 17) as to the marked differences in speech development between children of the upper and lower socio-economic classes, but the results of this study are not at variance with them. Fourteen of the 39 children whose blanks were completed most quickly have parents belonging to the professions.

A study of children's questions would not be complete without some comparison with the questions of

TABLE 1

Distribution of cases by age and sex and mean length of questions in words

AGE	BOYS				GIRLS				BOTH		
	Number of cases	Range of age	Mean age	Mean length	Number of cases	Range of age	Mean age	Mean length	Number of cases	Mean age	Mean length
years		*months*		*words*		*months*		*words*			*words*
3	2	34–41	37.5	5.09	5	32–39	37.2	5.61	7	37.3	5.46
4	10	42–51	46.3	6.24	5	48–53	50.6	6.32	15	47.7	6.27
5	7	54–61	57.7	6.27	4	55–62	57.7	6.71	11	57.8	6.43
6	7	66–76	71.0	6.89	8	67–76	71.0	6.97	15	71.0	6.93
7	6	79–89	84.8	6.51	7	80–88	82.6	6.00	13	83.6	6.72
8–12	7	97–140	114.1	6.28	5	95–131	111.6	6.64	12	113.1	6.43
Younger group	19	34–61	49.6	6.13	17	32–60	51.4	6.27	36	50.4	6.19
Older group	20	66–140	90.3	6.56	17	70–131	88.2	6.80	37	89.3	6.72
All.....	39	34–140	70.0	6.35	34	32–131	69.8	6.59	73	69.9	6.46

* From the Institute of Child Welfare, the University of Minnesota. The coöperation of the mothers who made this report possible is greatly appreciated. Grateful acknowledgment is also made to Dr. Esther McGinnis and the Parent Education staff for distributing blanks and interesting mothers, and to Dr. John E. Anderson, Dr. Florence Goodenough, and Dr. Mary Shirley for advice and assistance in preparing the material for publication.

adults. To obtain an adequate sampling of adult questions proved impossible, so following the example of Boyd (4), recourse was had to the printed page. Fifty questions were taken from the conversation of two male and two female characters of contemporary fiction, and these were supplemented by 300 questions extracted from legal testimony as published verbatim in newspapers. To what extent the fact-finding objective of the court situation held the questions to stereotyped forms as compared with random conversation is unknown, but the material has the merit of being actual spoken language recorded on the spot by experts. These 500 questions were classified like those of the children, and comparisons were made on a percentage basis.

RESULTS

Seventy-three records, 39 for boys, 34 for girls, were returned, making a total of 3,650 children's questions for analysis. The age distribution of subjects is given in table 1. The distribution is continuous, the four year group, for example, containing all children whose ages fall between three years six months and four years five months. Because of this fact, and the small and variable number of cases at each level, year by year comparisons like those made by McCarthy (17) are impossible, but comparisons on the basis of an older-younger division reveal certain age differences. When sex differences in the two groups are presented, the reader should bear in mind that the younger boys are slightly younger, the older boys slightly older, than the corresponding girls.

Length of questions in words

Nice (19) suggests that length of sentence affords a simple criterion of advance in mastery of speech, and McCarthy (17) found an increase from year to year in sentence length. Table 1 shows a similar slight but consistent increase in the length of questions. The difference in mean length between younger and older age groups is statistically significant (D/SD dif. 6.55), but the total range in length is very constant for both groups. The questions of girls are probably significantly longer than those of boys (D/ SD dif. 2.55). The distribution according to length in words for younger children, older children, and adults is shown in Fig. 1. The similarity of the curves suggests that the four to six word question is best suited to the expression of interrogation in the English language. Comparison of mean length shows that the questions of adults are significantly longer than those of children (D/SD dif. 9.70), but 42 per cent of the adult questions are of six words or less, and only 7 questions out of the 500 exceed the maximum length for the children. Fig. 2 compares the length for boys and girls, and here the curves are almost identical.

Time required to obtain fifty questions

Although instructions on this point were explicit, some recorders did not make it clear just how long the child was under observation. If John comes in from school at 3:30 p.m. and asks a question, but there is no further entry until 6:30 p.m., are we to assume that he asked no questions during that time? If the record goes on thus for

five or six days, we suspect that the mother is noting only the exceptional and striking questions, which is the very thing we wished to avoid. Sixty-one blanks (29 boys, 32 girls) were filled out accurately enough to make analysis of time possible, but the results as stated in table 2 were indefinite. The time range was from 30 minutes to 14 hours 5 minutes, but the

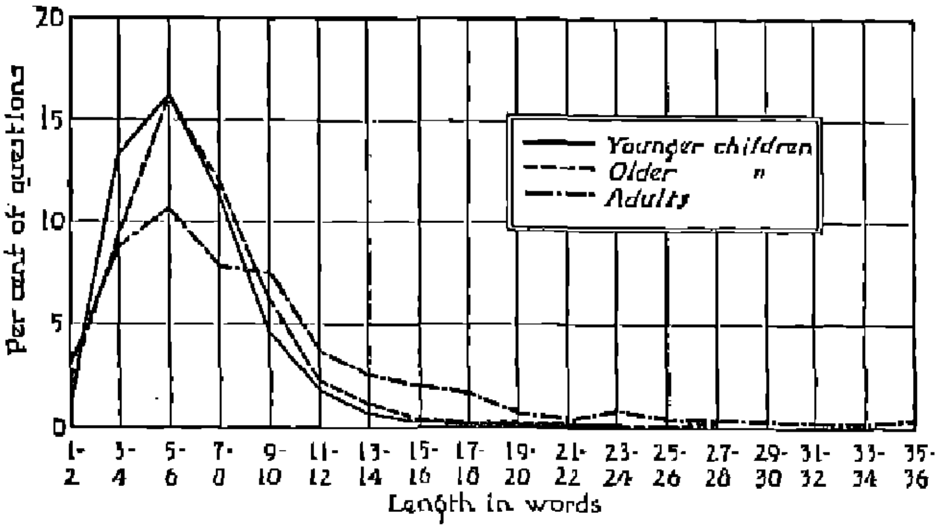

FIG. 1. PERCENTAGE DISTRIBUTION ACCORDING TO LENGTH OF QUESTIONS ASKED BY THREE AGE GROUPS

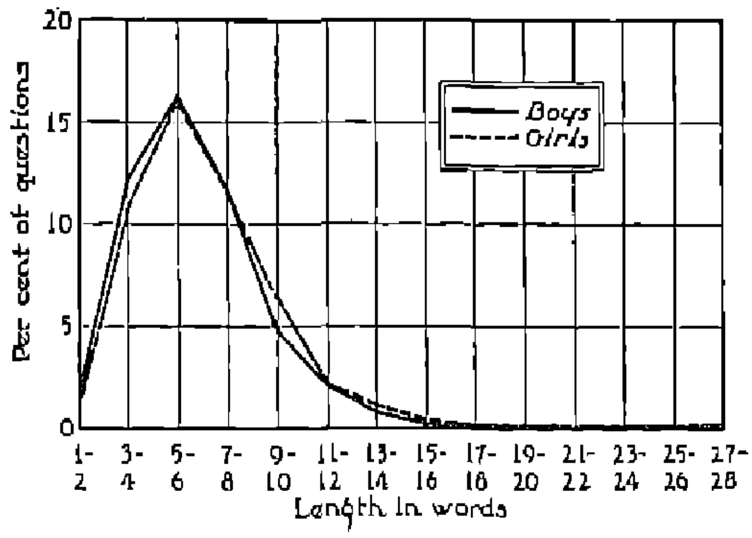

FIG. 2. COMPARISON BY SEX OF PERCENTAGE DISTRIBUTION OF CHILDREN'S QUESTION'S ACCORDING TO LENGTH

TABLE 2

Mean time required to obtain fifty questions using 61 records

	YOUNGER GROUP		OLDER GROUP		TOTAL RANGE
	hours	*minutes*	*hours*	*minutes*	
Boys	3	36	3	12	30 minutes to 10 hours 40 minutes
Girls	3	17	4	16	50 minutes to 14 hours 5 minutes
Both	3	26	3	44	

writer seriously doubts whether the time is accurately stated when the total period is many hours long. Question asking is variable, depending on the situation, the interest of the moment, fatigue, and many other factors. One mother returned two blanks obtained from the same child at an interval of two months. The time for obtaining the first quota was 9 hours 55 minutes, for the second, 5 hours, 15 minutes. It seems clear that the situation does not necessarily determine the rate. Table 3 shows that children 1 and 10 asked their questions on motor trips in 38 and 56 minutes respectively. On two occasions the writer recorded questions asked by boys on motor trips, when the parents were present and the child was under accustomed surroundings; yet child 26, aged seventy-six months, asked only 36 questions in 3 hours 45 minutes, and child 35, aged one hundred nine months, asked 20 questions in 5 hours and 45 minutes. In view of the inconclusive findings in regard to time it was decided to compare the 15 boys and 15 girls whose records were completed in the shortest time, since there is little likelihood of error where records are nearly or quite continuous. Table 3 indicates that boys ask questions faster than girls, but there is no evidence that the rate falls off with advancing age.

Circumstances under which questions were obtained

Table 3 also summarizes the situations under which the greater part of these continuous records were made. The circumstances seem fairly representative of the usual interests and activities of the ordinary child. One constant factor (of writing being done) was present in every situation save one, where the mother sat on a screened porch and recorded the questions as they were asked of a neighbor. How foreign this writing was to the child's usual experience of course depended on the every day routine of the individual home. Forty blanks contained no questions due to the writing, 13 contained one, 9 contained two, and so on, up to a maximum of twelve. In the last named instance, the questions were recorded during Sunday dinner, and writing at the table was of course a novelty. Eighty-six questions out of the 3,650 were attributed to the writing, and these were of very great variety. The most frequent was, 'What are you writing?' This was often followed by asking why the Institute of Child Welfare wanted to know, or when the mother would be through. Several children wished to do some writing themselves, to borrow the pencil, or to use the desk. One four-year-old boy at lunch asked, 'Do you see how I do like you—write in between bites?' Others wondered if the mother were writing a letter, a poem, a recipe, or an encyclopedia. Special note was made of these 86 questions, since there was no other factor common to all the situations under which questions were obtained, and no other unusual occurrence resulted from the recording. That it was not unusual to all the children is indicated by the fact that more than half the records were not influenced by it at all.

TABLE 3

Age, time required, and situation under which questions were asked, for 15 boys and 15 girls whose records were obtained in the shortest time

	Child	Age	Time	Situation
		Boys		
		months	minutes	
Younger group	1	47	38	Motor-car trip down town
	2	47	117	Household routine, playing with brother
	3	48	48	Lunch hour
	4	49	110	Playing with new toys
	5	57	60	Lunch hour
	6	60	40	Discussing adult activities
Average		51.1	69.8	
Older group	7	61	103	Morning routine
	8	61	98	Solitary play
	9	66	60	Trip down-town, street-car
	10	72	50	Motor trip, Duluth to St. Paul
	11	74	85	Conversation on porch, adults and children
	12	79	65	Play with friend, age 89 months
	13	89	90	Solitary play
	14	89	30	First visit to friend, age 89 months
	15	108	45	Constructive play with friend 89 months
Average		66.5	70.2	
Average all		66.4	70.0	
		Girls		
Younger group	A	32	118	Outdoor play, mainly in swing
	B	39	128	Household routine
	C	30	130	Sunday morning routine
	D	53	79	Morning routine
	E	55	120	Playing with sister, age 88 months
	F	62	109	Breakfast and lunch
	G	67	90	Play with friend, boy, age 90 months
	H	68	50	Solitary play, drawing
	I	69	51	Solitary play, talk with adult friend
Average		52.7	96.4	
Older group	J	73	81	Sunday dinner
	K	80	145	In bed with mumps
	L	88	94	Play with sister, age 55 months
	M	95	140	Morning routine and walk to school
	N	100	90	Sunday morning routine, making cookies
	O	131	122	Sunday morning routine
Average		94.5	107	
Average all		60.4	101.7	

Significance of difference in time for boys and girls (D/SD diff.) 3.03.
Eighty per cent of girls reached or exceeded median time for boys.

THE FORM OF QUESTIONS

There seem to be in English two principal ways of asking questions. They may begin with one of the interrogative words, or with an inflected form of one of the auxiliary verbs. Piaget (21, p. 219) calls the latter "simple questions," and does not differentiate the various auxiliaries in accordance with frequency of use. In English, however, these "simple questions" are nearly always expressed by means of the auxiliary *do*. Where the French say *Pensez-vous?* the English say, *Do you think?* The importance of these auxiliary verbs has been demonstrated by Stormzand and O'Shea (26) who found on analysis of 10,000 sentences selected from literature, newspapers, and school compositions that 68 per cent of the verbs used were irregular, and that the auxiliaries were used three times as often as all other irregular verbs put together. Since the inflection of these verbs has to be learned by long practice, and since their use expresses shades of meaning less essential than the main verb, we would expect the young child frequently to omit them altogether, and here lies a partial explanation of the increase in sentence length with advancing age. For the purposes of this study the emission of the interrogative word or of the expected auxiliary form renders a question incomplete. It is also possible to ask a question merely by the tone of the voice, as *You live in Minneapolis?* This sort of question was seldom found on the children's records. More frequent was the addition of *can't I*, or *doesn't it?* to a declarative sentence. McCarthy (17) did not classify these as questions, because she was following Piaget's socialized—egocentric classification. While questions are *ipse facto* socialized, many sentences of the type under consideration are egocentric in that they express the desire for approbation and corroboration noted by Snyder (24) and Smith (23), or for social contact described by Johnson (14). But to have told mothers to leave out such questions would have made instructions, already long, much too complicated, and would have introduced a large source of error. Moreover, Piaget, includes such questions in the study described in Chapter V (21) and if we accept Claparede's definition of a question as "the conscious realization of a problem" whose function is "an incitement to mental activity in a certain direction in view of readjustment" there is justification for such a course. If complete certainty existed, it is not likely that the question would have been asked. It is not easy to detect a difference between *Uncle Ed lives in Chicago, doesn't he?*, and *Doesn't Uncle Ed live in Chicago?* especially from the written form. Such questions have been listed separately under the heading Declarative plus Interrogative. The percentage distribution of questions among these four categories were tabulated. Boys are more likely than girls to begin their questions with interrogatives (D/SD dif. 3.31); girls are more likely than boys to use the auxiliary verbs. Adults use fewer interrogatives and more auxiliaries than children, hence the sex difference may be due to the slight superiority of girls in language development which has been demonstrated in other studies. On the other

hand, boys ask more questions involving cause or explanation, and usually begun by *why, what for, what makes,* or *how*, while girls were found to ask more questions involving permission, and other social relations, which begin with *may I, shall I*, and similar phrases. In short, the obtained difference in question form may be the result of unequal ability in handling the instrument of language, or of dissimilarity in the interests motivating expression. The fact that older girls use a significantly greater number of auxiliaries and smaller number of interrogatives than younger girls (D/SD dif. 3.65, 3.35) suggests that both maturation and training are involved.

Adults are more prone than children to omit the interrogative word, or the auxiliary form which expresses interrogation. This was more marked in the questions taken from fiction than in the legal testimony. The inflected forms of the auxiliaries seem to be much more frequently omitted than the interrogatives by both children and adults. The obvious interpretation is that the adult, having mastered inflection, leaves out non-essential words to save time, while the child who is still having difficulty with the precise shades of meaning conveyed by mood and tense, is painstaking in putting them in. The use of the declarative-plus-interrogative form seems to be an individual rather than a sex or age characteristic, although it is possible that situation and mood may have some bearing.

We would expect questions begun by auxiliary verbs to be longer than those begun by interrogatives, and this was found to be the case.

FUNCTIONAL ANALYSIS

In making a functional analysis of the questions Piaget's classification system was followed, with the addition of a category for social relation and one for rhetorical question. These changes were necessitated by the greater variety and complexity of situations under which these questions arose, and perhaps by the greater freedom of the American parent-child as compared with the French teacher-pupil relationship. That Piaget's scale is a usable instrument is indicated by the score-rescore reliability of .88 obtained by the writer while still in the early stages of the work of classification. Similarly, a colleague who has never read Piaget's book and who was asked to classify the 86 questions mentioned above as arising from the child's reaction to writing, questions which were much more difficult to classify than a random sampling, did the scoring with a relability of .77. The doubtful cases fell for the most part in the categories of Reality and Classifications, in which the distinctions are sometimes finely drawn. Confusion of causal, action, or social questions almost never occurred. In general the scale was satisfactory.

The results of the classification according to function are shown in Figs. 3 and 4. The distribution for both age and sex is surprisingly constant. As we would expect because of the small number of questions per child the standard deviation for the categories is always large. Thus, questions of cause ranged from 0 to 22; of social relations, from 0 to 25. Although there are few differences between categories which are statistically significant, there

are several which are of interest as indicating trends. Boys ask more questions of causal explanation than girls (D/SD dif. 3.07); they also ask more questions involving classification (D/SD dif. 2.03) and definition (D/SD dif. 2.95). Girls, however, effect of the school system and social pressure on the spontaneity of language, but the data offer no evidence that the rate of question asking declines with age. Reference to the distribution of causal questions by years does show that a drop occurs at about

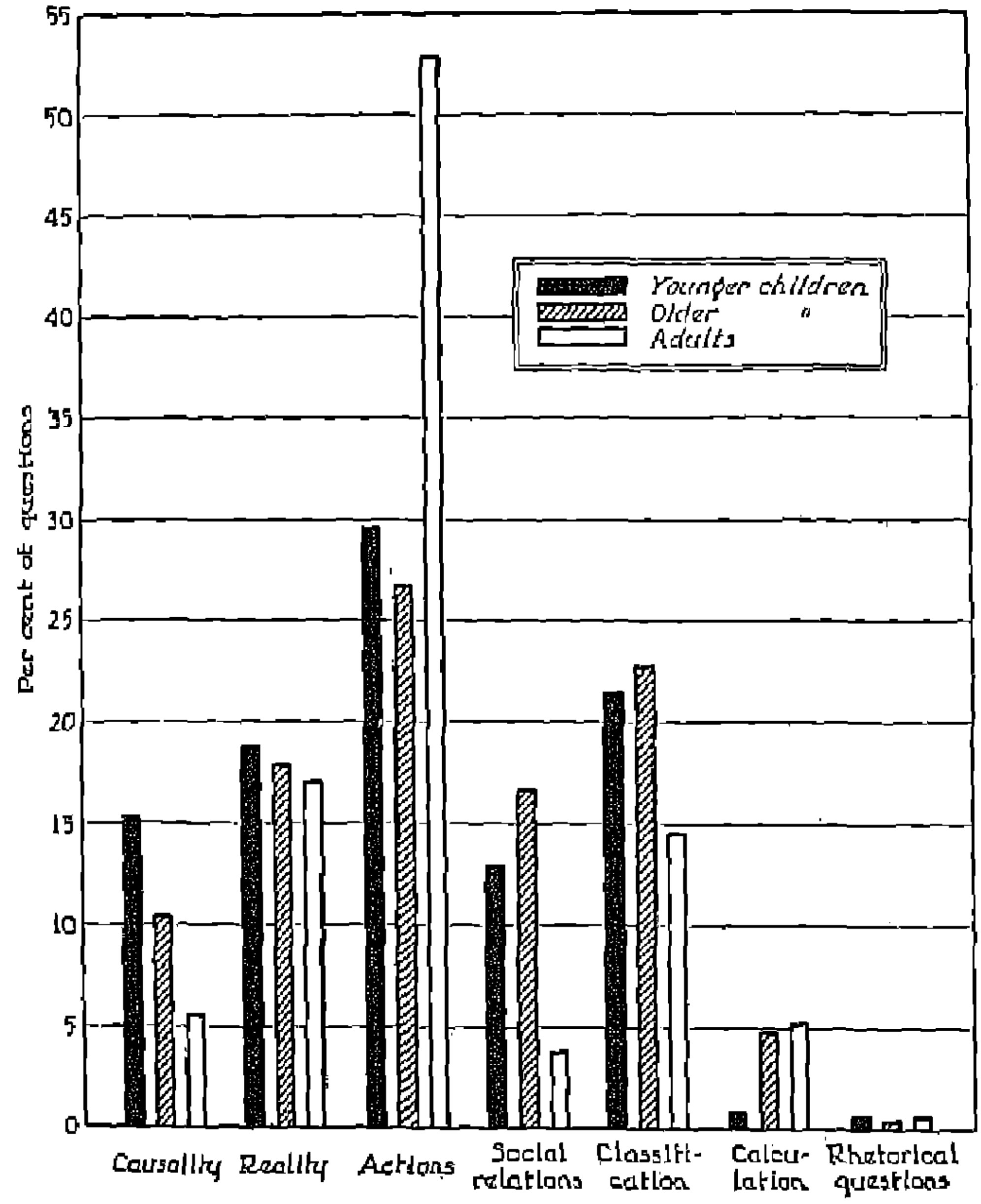

FIG. 3. PERCENTAGE DISTRIBUTION AMONG THE FUNCTIONAL CATEGORIES OF QUESTIONS ASKED BY THREE AGE GROUPS

ask more questions involving social relations than boys (D/SD dif. 3.04). Younger children ask more questions of cause than older children (D/SD dif. 2.13). This finding, to the earlier writers (3, 13, 20, 27, 32, 33) would constitute proof as to the crippling the time the child is learning to read. Certainly it is just as probable that reading affords a new opportunity of finding out things, as that the child is discouraged by the attitude of adults. Questions of calculation apparently receive an impetus with the beginning

of the school age, although the increase is not statistically significant. Boys may ask more questions in regard to meaning of words because they have rather more difficulty than girls in acquiring vocabulary.

Analysis of the data shows that the difference between boys and girls in the number of questions involving social relations lies for the most part in the much greater number of permissions and questions showing a subordination of self to others on the part of the girls such as, '*Shall I help you make the beds?*' This may be the result of the situation involved, or may mean earlier socialization of girls in regard to their relations with others. The small percentage of causal and social relations questions asked by adults may be in part the result of the situation, but the relative importance of the categories was the same for the questions taken from fiction and for those taken from legal testimony.

Analysis of the functional categories by length yields statistical confirmation of some obvious facts. It is apparent that more words are required to ask *Why do you write so fast?* or *Are we all going for a walk through the park?* than *Is this red?* or *What does "obsolete" mean?* That is, we would expect questions of Causality and Actions to be longer than questions of Reality and Classification, and this is true at all ages and for both boys and girls.

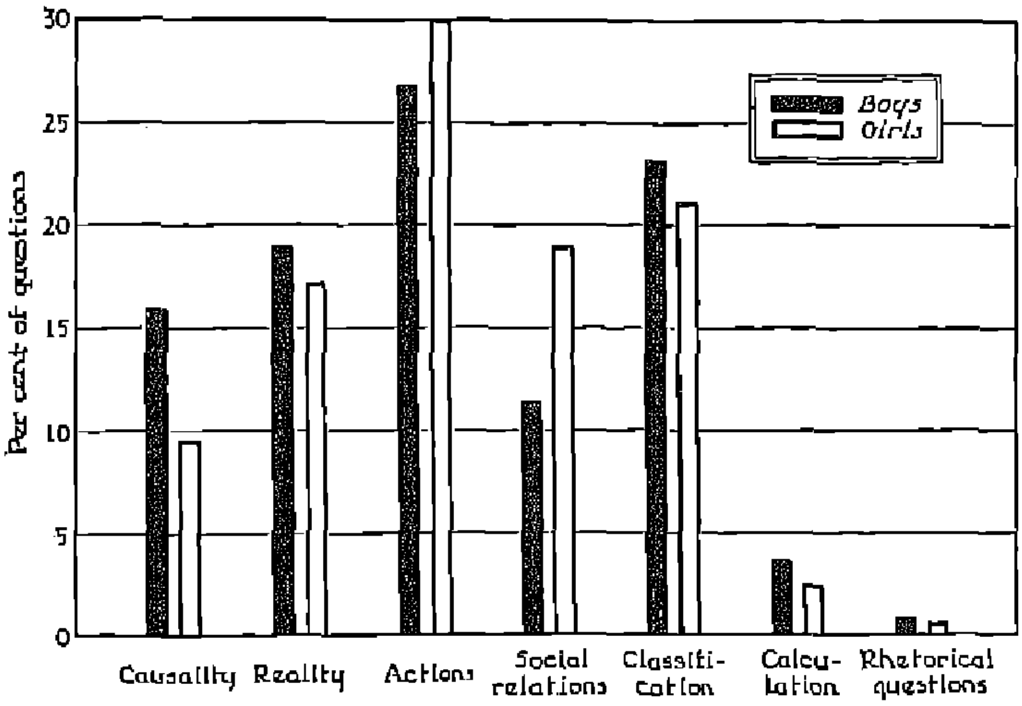

FIG. 4. PERCENTAGE DISTRIBUTION AMONG THE FUNCTIONAL CATEGORIES OF QUESTIONS ASKED BY BOYS AND GIRLS

PERSONS QUESTIONED

Piaget (21) concludes that children are prone to question other children in regard to actions and intentions, or "the factual aspect of reality," whereas questions asked of an adult concern causes and motives. In order to test this point, questions were classified according to the persons addressed. The divisions were mothers, fathers, all other adults (maids, plumbers, aunts,

grandfathers, even strangers on the street), children within a year and a half of the child's age, older children (the age of sixteen was arbitrarily taken as the point at which a child became an adult), younger children, animals, dolls, and no one in particular. In the final analysis all children were thrown together, as there semed to be no difference in type or length of questions asked of older or younger children. The percentage of questions asked of *other adults* varied greatly, because some records were made by aunts or adult friends, and there was always a chance factor involved in the selection of a certain time or place for recording questions. The most interesting result of this analysis is the large percentage of questions asked of the mother and the small but constant percentage asked of the father. No conclusions may be drawn, however, since in many instances recording was done in the partial or total absence of the father, nor do the records enable us to estimate to what extent the child had the opportunity of addressing the father. 18 girls and 21 boys asked no questions of the father.

The child-adult comparison suggested by Piaget yields only negligible differences, although it is true that the percentage of causal questions asked of children is slightly smaller, and the percentage of action questions slightly larger, than the corresponding percentages asked of adults. Boys address a large percentage of their questions of calculation to the father. Girls ask fewer questions of cause of the mother and of children than of the father and of other adults; boys, on the other hand, address more causal questions to the mother. All children nat-

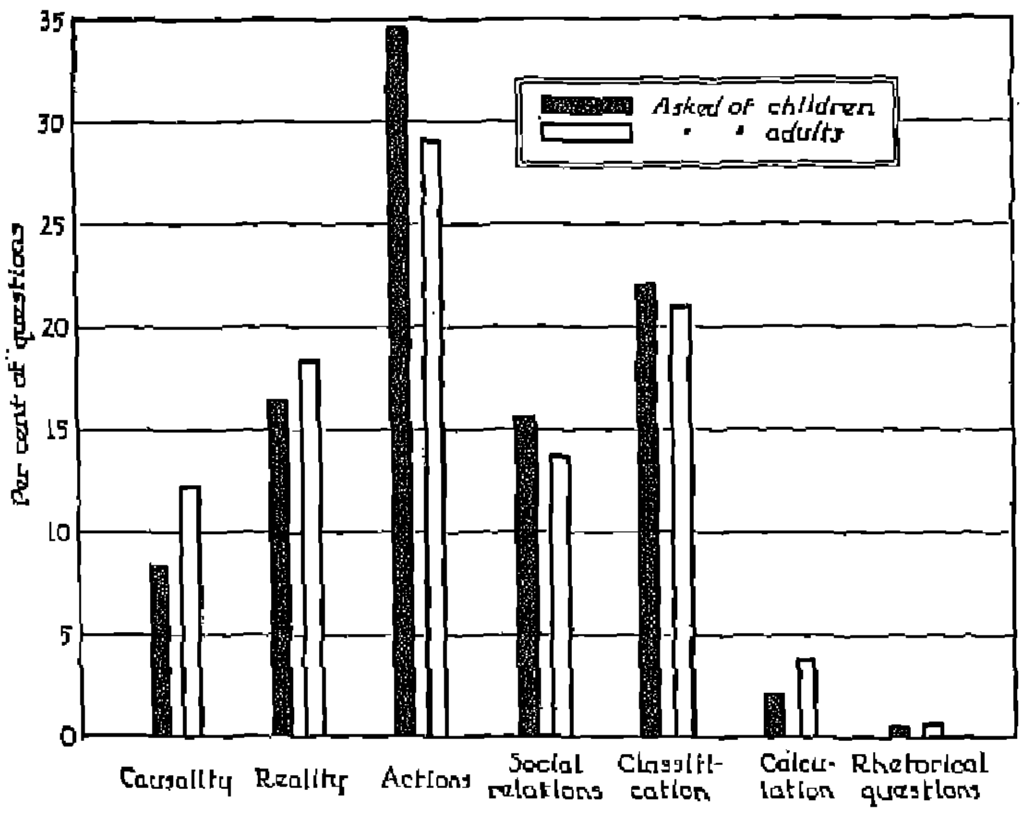

FIG. 5. PERCENTAGE DISTRIBUTION AMONG THE FUNCTIONAL CATEGORIES OF CHILDREN'S QUESTIONS ASKED OF CHILDREN AND OF ADULTS

urally enough address fewer questions of social relations to other adults than to their parents, whose authority they recognize. The percentage of such question asked of children, however, is only slightly below that of questions asked of parents, indicating that these children are well imbued with respect for the property and personality rights of other children, and are meticulous in requesting rather than commanding their cooperation. Fig. 5 compares the questions asked of children with those asked of adults.

The only statistically significant difference between questions asked of adults and those asked of children was in length, questions addressed to adults being longer (D/SD dif. 5.50).

SOURCE OF QUESTIONS

Of the 3650 questions, 87.8 per cent were attributed by the mothers to something in the immediate situation; 10.8 per cent to remembered or remote events; 1.4 per cent could not be accounted for by anything in the child's known experience. This classification is necessarily rough and there is no check on its reliability. Because of the widespread interest in the memory of young children the remote questions were studied in detail, but with little result. The mean number of such questions per child was 5.41, with a range from 0 to 18, and with no age or sex difference. Questions dealing with past events tend to fall into the categories of Reality and Actions, but on the whole the percentage distribution of Remote questions among the functional categories corresponds very closely to the total distribution. More Remote questions are asked of adults than of children, and Remote questions are significantly longer than immediate questions (D/SD dif. 5.25). Girls ask 14 per cent of their Remote questions of the father, and 70 per cent of the mother. Boys ask 1.4 per cent of the father, 77 per cent of the mother. There is a suggestion that Remote questions are prone to originate from conversation with adults.

ORIGIN OF QUESTIONS

It would seem very possible that some activities and situations are more likely to call out questions than others. Mothers were asked to classify the origin of each question as best they could under eight suggested headings, conversation of adults, conversation of children, stories, pictures, activities of children, activities of adults, personal routine, and miscellaneous. The records indicate that the mothers used great care in this classification, frequently clarifying their decisions by explanatory notes, hence their classification was accepted even in cases where there was apparent contradiction. The question, *What time is it?* was found under nearly every one of the eight headings, since it might result from hearing adults discuss the hour of a concert, from anxiety over being late for school, from looking at a pictured clock, or from the desire to dress or undress in record time. Furthermore, conversation with children and adults may be going on simultaneously, and was sometimes so recorded. Because of this very elastic classification the data are considered only as suggestive of trends. Conversation with adults showed the

highest percentage of the activities calling out questions.

INTERESTS OF CHILDREN AS INDICATED BY QUESTIONS

An attempt was made to determine the interests of these children on the basis of their questions, as was suggested by Hall and Smith (11). The mothers were not asked for any impressions as to the children's interests, hence the question with an occasional explanatory note was the only source of information. Obscurity as to the interest involved made it necessary to eliminate 242 questions from consideration. The usual interests of children of the age range under consideration were tabulated from the Anderson-Goodenough Baby Book and the Lehman and Witty Play Quiz, and the questions checked against this list. A few items had to be added, and one (collecting) was not represented in the questions. The result was a list of 53 items some of which are themselves comprehensive. Thus, *Active and Competitive Play* included organized athletics and the activities of Boy Scouts as well as random outdoor play; *Constructive Play* might mean making doll clothes or building with Lincoln Logs. It was necessary to combine such items to keep the list within bounds and to obviate the necessity of classification under two headings where there seemed to be overlapping of interests. Any list of this kind is likely to be affected by personal bias, but in the majority of instances the interest is clear.

The interests were tabulated in two ways, the number of questions in which a certain interest could be detected, and the number of blanks on which it was found. When the items were ranked in the order of their frequency of occurrence from greatest to least, the coefficient of correlation (Spearman rank-order formula) was found to be 0.94, hence the results are given for one method only (the first). Age and sex differences where found were in keeping with previously established differences in play equipment, mental test scores, and educational achievement. Boys asked an average of 3.3 questions about machines (airplanes, motors, engines, trains, mechanical toys), girls 1.8 questions. The 20 older boys asked 6 questions in regard to school and homework, while the 17 older girls asked 31 questions. Girls asked slightly more questions in regard to household work (average 1.88, for boys 1.28). The younger boys asked 16 questions about personal appearance, the younger girls 17; the older boys 2, the older girls 21. Clothing irrespective of personal appearance ('Where are my other bloomers?' 'Do I need my sweater?') received more attention from girls (average 2.35 questions, boys 1.36). Boys asked an average of 1.74 questions in regard to natural history, excluding farming and pets, girls 1.15 questions. Natural phenomena, such as weather, storms, meteors accounted for 1.95 questions of boys, 1.47 girls. Questions in regard to meaning and use of language averaged 3.15 for boys, 2.82 for girls.

The degree of community of interests between boys and girls, and between older and younger children, was determined by computing the

coefficient of correlation (Spearman rank-order formula) between the frequency of occurrence of each item for boys and for girls. These indicated a decrease in community of interests between boys and girls with advancing age, and there is a suggestion that the difference between the interests of older and younger boys is greater than that between older and younger girls.

That a community of interests exists is further demonstrated by comparing the extremes of the distribution for boys and for girls. Six of the ten most frequent items and four of the ten least frequent items are found on both lists, and in no case is an item at one extreme for one sex and at the opposite extreme for the other.

Interest in theology and sex seems to be very slight. Very probably the findings of other investigators (11, 30) were affected by the fact that the records were made from memory. Obviously the amusing or unusual question is recalled, while the common place query in regard to some matter of every day life is not. These five questions concerning the nature of God were asked by five boys, all less than six years old:

God has wings to get down with, hasn't he?
Did Marje see God? (sister claimed she had)
Why does God give us pigs to eat?
Is God there? (in Ceylon)
Does God hear this? (blowing horn).

Forty-nine questions dealt with denominational differences and going to church, including these references to the Resurrection:

Is Jesus dead now?
Mother, what does "He is risen" mean?
How did the angel know Christ was risen?
Mother, why did *that* angel (picture) have a palm leaf in her hand when the ladies came to Jesus' grave?
How *did* Jesus get up?

Seventeen of these 49 questions were asked by one six year old boy, in regard to Catholics and convents.

Only 14 questions were found which could be classified as sex questions:

What is this skin for? (testicles—child in bath)
Will she have baby birds some day?
Does the baby calf come out of the mother?
Do they look like little seeds?
What do they look like when they are in the mother?
Who are I going to marry?
Will I ever marry when I grow up?
Do the baby deer come out of an egg like the chickens do?
Where do the baby deer come out of the mother deer?
Does it hurt the baby deer when it comes out of the mother deer?
What is this? (germ plasm in egg)
How did it get there?
What do they (little chickens) do when their mother leaves them?
You wouldn't *think*, would you, that this little speck could grow into a chicken?

SEQUENCES OF QUESTIONS

Every observer of children has noted the frequency with which a long series of questions is set off by a single remark or occurrence. To Wallon (31) this is pathological, and Faegre and Anderson (9) caution parents against trying to answer all their children's questions fully and completely. The records were analyzed to discover a possible age or sex difference in the number of questions on a single topic or logically following from a former question, and to determine whether

there is a tendency for sequences of questions to center around certain interests. Note was made of all cases where two consecutive questions were thus related, and if three or more consecutive questions dealt with a single topic or were logically interrelated these were listed as sequences and studied in detail. There were found to be 238 sequences. Every blank contained at least one sequence, and one blank yielded seven. Forty-four of the 50 questions on one blank were in sequence. The average length of sequences was 4.44 questions. The longest sequence was that of 17 questions on denominational differences mentioned above. There was one of 16 questions on making doll clothes, and one of 14 questions on the procedure at funerals.

Analysis by age and sex did not show any difference in the number of questions on a single topic. The mean number of consecutive questions on a topic for younger boys was 1.68; for younger girls 1.54; for older boys 1.52; and for older girls 1.58.

If we may assume that length of sequence is a rough measure of strength of interest, the next step is a comparison of the number and length of sequences concerning the various interest items with the frequency of such items for the total distribution. Sequences proved hard to classify, since the last question of the series may touch on a topic far removed from the original question. One boy began with *What kind of meat is this?* and ended with *Where will I work when I grow up?* yet the logical procedure from question to question was perfectly clear.

Classifying the sequences as well as possible, 41 of the 53 interest items seemed to serve as the central topic of a sequence. The 12 items not represented are sleeping, personal appearance, occupations, farming, memory and opinion, social relations, current events, sex, acts of affection, colors, God, dreams and fears. Money, fires, circuses, birthdays, other places and peoples, war, and helping are found in the boys' sequences but not in the girls'; jokes, electricity, school, government, funerals, diseases are found in the girls' but not in the boys.' These sex differences mean little, since the frequency of occurrence in one sex but not in the other is never greater than two.

This analysis of sequences according to the interest involved yields nothing conclusive, but there is a suggestion that for this group of children a long series of questions results from an unusual occurrence or novel bit of conversation, rather than from the desire to attract attention or the lack of adjustment which is Wallon's explanation (31).

It might be expected that a connection would be found between the type of question beginning a sequence and the length and general topic of the sequence. When a child asks a causal question is he in a "frame of mind" which leads him to continue asking questions? Analysis of the initial questions of sequences yields no evidence that this is the case. The first questions fall into the functional categories in very nearly the proportions obtained for the total distribution, and no one type of question tends to produce long or short sequences. These findings like those of the other analyses indicate that children are motivated

to ask series of questions by actual interest in something going on. There is no temporary "set" toward classification, causation, or merely getting attention.

SUMMARY AND CONCLUSION

Further study of children's questions along many lines is needed before any definite conclusions can be drawn. The data analyzed here indicate that the child in the present day American home of the upper socio-economic levels employs questioning, as does the ordinary adult, because it is an efficient and convenient means of extracting satisfaction from contact with other people, acquiring information about external reality, perfecting his command of the instrument of language, and achieving adaptation to the physical and social environment in which he finds himself.

The findings of this study may be summarized as follows:

1. Analysis was made of 3650 questions asked by 73 children between the ages of three and twelve years, and recorded at the time of asking. For purposes of comparison 500 questions asked by adults were taken from printed material.

2. Boys asked questions at a faster rate than girls but younger children did not ask them faster than older children.

3. The length in words of the questions increased with age. Girls' questions were somewhat longer than boys' questions. Questions of 4 to 6 words were characteristic of both children and adults.

4. Boys more often than girls began their questions with interrogative words; girls more often than boys began their questions with inflected forms of the auxiliary verbs. The use of questions declarative in form with the addition of an interrogative phrase, or the omission of the interrogative, seemed to be an individual rather than a sex or age characteristic.

5. Boys asked more questions involving causal explanation than girls; girls asked more questions on social relations than boys.

6. Causal and action questions were most frequently 6 words in length, questions on reality and social relations 5 words, those on classification 4 words.

7. Eighty-six per cent of the questions were asked of adults, thirteen per cent of children. Questions asked of adults were longer than those asked of children, but there was no conclusive evidence of a difference in type of question addressed to adults.

8. Eighty-eight per cent of the questions seemed to result from the immediate situation, eleven per cent from remote events. Remote questions were longer than other questions and were asked of adults more often than of children.

9. The interests of boys and girls as indicated by their questions seemed to be very similar. The difference between boys and girls increased with age, and the interests of boys changed with age more than those of girls.

10. There were no age nor sex differences in the tendency to ask a series of logically related questions starting from a single topic. Although a novel occurrence seemed more likely to call out a very long series of questions, any of the ordinary situations might serve as a starting point for such a series.

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Brief Reports

Lessons in Child Training Gleaned from Idiots*

IDIOCY, with its unhappy associations, provides, under a cloak of imperfection, many interesting facts about personality and intelligence. The scientific study of idiocy reveals implications for training and suggestions for understanding not only the idiot child but also the normal infant whose mentality is quantitively comparable to that of the idiot. At least, such is the conclusion drawn from a group of experimental studies of idiot behavior, conducted at The Training School at Vineland, with a group of twelve idiot children as subjects.

These idiot children, according to standard mental tests, were of the same general ability as normal preschool children. Preschool children, however, mature so rapidly that their behavior is a result of both growth and training, while the idiot remains indefinitely at the same level, and significant improvement may be attributed to training alone.

This fact enables us to observe training results in the idiot which, in the preschool child, are obscured or confused by his rapid growth. In other words, the idiot child presents a slow-motion picture of the rapidly maturing preschool child, and thereby reveals many facts impossible to observe among preschool children themselves.

Like babies, idiots have learned to rely upon adult attention to satisfy their wants. Fruit is handed to them in prepared form, toys are placed within easy reach, and the only test of their actual ability comes in their spontaneous play, when adults are not in constant attendance. At such times their meager intelligence, initiative and imagination are summoned to action, only to be distracted by a passing playmate, a bright color or a sudden noise. With some, attention shifts from one object to another without logical sequence, and their activity, on the whole, seems random and unorganized. Others of the group may become so engrossed in a single activity, such as buttoning a certain button or raveling out a thread, that their distractibility assumes opposite proportions.

Unlike normal babies, however, idiot children never outgrow this period of dependence and distractibility, except as they are trained to capitalize their meager talents.

Inasmuch as language represents the greatest divergence between the idiot and the preschool child, we sought to use situations entirely devoid of the language factor. Such situations

* These studies were completed under two financial grants from the Elmhirst Fund while the author was Research Fellow, The Training School at Vineland New Jersey. She is now Research Assistant, The Mooseheart Laboratory for Child Research, Mooseheart, Illinois.

seemed more accurately to measure the capabilities of the levels of two to three years. Another advantage in the elimination of language was the avoidance of personality differences among teachers or observers. Children will frequently respond to the mother when the same commands, given by another person, elicit no response. Likewise, different teachers often obtain different returns from training the same children. We were interested in seeing what the child could and would do of his own accord, and what elements in the situation influenced his reactions, aside from adult influences. Therefore, the use of language and the presence of adult observers were eliminated so far as the child was concerned.

Records were kept by an observer, watching through a one-way-vision screen. Such a screen, by the way, might be an interesting and useful addition to every nursery. A mother frequently breaks up a happy play period merely by her presence, which distracts the child from the task at hand. By the use of a one-way-vision screen in those early years when constant supervision is necessary, the child might be, apparently, left alone to amuse himself, thereby developing resourcefulness and independence that will be priceless in years to come.

For these studies we devised problems, simple to the adult, but of sufficient difficulty to the idiot to permit observation and analysis of his behavior and its relation to the problem. In the first problem, a large, brightly colored ball, a favorite toy, was suspended from the ceiling, and boxes, varying in height, were scattered about the room. In order to obtain the ball it was necessary for the child to stack the boxes under it and climb upon them.

Nearly every child, upon entering the room, immediately saw the ball suspended from the ceiling and was attracted to it. Some stood by apathetically, looking up at the ball; several ran toward it, jumping and reaching; some looked for a means of solution; others whimpered and cried for their desires, without any spontaneous effort; and still others, perfectly capable of making the solution, waited until they were told to go ahead. George, whose mental age was only 18 months, ran toward the ball, reaching for it. He ignored the box completely. After several unsuccessful trials, the box was placed beneath the ball for him. He ran toward the ball and climbed on the box, but immediately became so engrossed in climbing on and off the box that, although the ball was now within his reach, he ignored it. George, like many other children (and adults) had become so distracted by the method that he lost sight of the end itself. Just as a child puts in and pulls out the laces of his shoe from sheer joy in the accomplishment, George climbed on and off the box. Before he could obtain the ball it was necessary for someone or something to remind him of his original goal. *The final achievement desired must be kept in the mind of the child of this level, and must receive his constant attention.*

One means of centering or increasing the child's attention was to increase the incentive. After three trials of ten minutes each, if the child had obviously exhausted all his possibilities

of successful solution, he was taken from the room. The ball was then supplemented by the addition of a cookie, to stimulate the child to greater effort. This increase in incentive proved highly successful. Children who had ceased striving for the ball and had begun playing with the boxes now renewed their efforts toward the ball and frequently obtained it. Some subjects, however, failed the problems even with the addition of a cookie to the lure. In these cases, we substituted a banana for the ball and cookie and awaited results. Buster, who had stood on two boxes but never three, because of obvious fear reactions, calmly piled three boxes together when the banana was offered. Not only did he stand upon them to obtain the fruit, but also while he ate it.

The increased incentive was not tried until it seemed apparent that the child was exerting every effort and that the problem was really beyond his ability. Yet, with the increased incentive, the problem was solved. This principal may be applied to the every-day problems of normal children. Why should a child learn to dress himself, for example, if failure brings attention and help, while success brings only momentary praise? *It is wrong to assume that a child's failure to learn is due to sheer stupidity until every possibility of increasing the incentive has been exhausted.*

Carl became confused when the solution offered two possibilities. The problem called for two half-cube boxes to be piled, one upon the other, but Carl saw also the possibility of standing the larger box on end, and using it alone. The boxes were so constructed that they could not stand on end without rocking, which made climbing upon them impossible. Carl tried again and again to climb upon the unsteady box, but failed repeatedly. Finally, the box fell on its base and he tried it that way. Finding it inadequate, he immediately brought the second box and placed it on the first, climbed up and obtained the ball. It seemed obvious from his behavior that the second solution, although much easier, did not occur to him as long as he was trying the first.

Children often become confused if there are too many possible lines of activity. *Training should be so systematized as to allow only one solution to each problem until it is too thoroughly learned to be confused with alternatives.*

In a second series of problems, the ball was placed in a pen, and sticks were supplied with which the child might obtain the ball. In these problems, like those utilizing the boxes, failure was often replaced by success when changes were made in incentive. Solutions were easiest when the necessary implements were in visual proximity with the lure. If the stick was inside the pen it was used more readily than when it was outside the pen. Although the stick stood against the outside of the pen, Jimmy struggled and reached repeatedly for the ball, lying prone in order to use his maximum arm length. Finally he gave up and began playing with the stick. Soon, however, he stopped, with stick in hand, to look at the ball again. As he did so, his eyes fell upon the stick and immediately he used it to obtain the ball. The stick in his

hand was closer to the ball than it had been against the wall, and probably made the solution easier.

A more difficult problem with the sticks involved joining two short bamboo rods in order to make one long enough to reach the ball. Two children were able to do this when the sticks were laid side by side, but both failed when the sticks were placed on opposite sides of the pen.

These incidents reveal the importance of a logical presentation of materials for maximum training results. The normal preschool child becomes confused by a mass of unorganized materials before him. Gradually, however, the mass clears as he develops greater comprehension. *The slow or retarded child, however, must have his world organized more systematically by his teachers if he is to approach the standard of training of his more precocious playmates.*

"Conditioning," a term which has become common by practical usage, was taken as the basis of the third study. The idiot children were "conditioned" to the smaller of two boxes; that is, after repeated trials, they established a preference for the smaller box, under which a cookie had been placed. The process of building up such an association is identical with that which occurs daily in the lives of young normal children. They choose certain forms of behavior because of pleasant associations, and discard other forms because of unpleasant associations. Habits or fears that seem impossible to overcome are often established in just such a way, and the association must be broken down before the act can be eliminated. How such an association could be most easily built up and broken down was the object of this study.

Each child was admitted alone to a room barren of all furniture except a table, on which there were two boxes, differing in size. No instructions were given, but after from 2 to 5 minutes every child had investigated the boxes and found, under the smaller, a cookie. After a varying number of trials, depending on the subject, the children learned to choose the small box immediately upon entering the room.

During the conditioning process it was noted that choices were made first on a position basis, that is, the box always on the right or always on the left was chosen consistently for a number of trials, regardless of its size. Most of these preferences were spontaneously overcome by the subjects themselves, although three children might have continued indefinitely except for a change in presenting the incentive. In these cases, half the cookie was placed on, and half under, the box until the child's attention was attracted to the small box. This made the association immediate rather than dependent upon memory of the previous trial, and is merely another instance of keeping the goal before the child throughout the learning period. As noted in the problem-solving study, children at this level of intelligence are extremely distractible.

Having built up an association between the small box and the cookie, the problem was reversed. The cookie was now placed under the large box, and in order to obtain it the child had first to inhibit the previously established choice. Throughout these prob-

lems only one choice was allowed in each trial. Therefore, the child could not succeed by a trial and error method but must definitely choose the box opposite the one to which he had been conditioned.

Every child continued, for a few days at least, to choose the small box. Then the preference began to be spontaneously overcome. It was interesting to note that the children who had taken the longest time to establish the first preference overcame it most easily, while those who had learned with relative ease persisted in their learned choice. This suggests that, *for those children who learn most readily, it is even more important to see that the correct habits are established first, since the ability to retain is apt to be as strong as the ability to learn.*

For two of the children, it was necessary to use an exposed cookie, placing it on the opposite box before their attention was drawn from that which they had learned to choose. Another interesting implication which comes from this observation of retentiveness is that the incentive is necessary in order to start an act and keep it up until learned, but, once having learned it, the child continues the act with less and less incentive. In other words, we may give a child much incentive for dressing himself, for example, by praising him or by offering other rewards, but these artificial incentives may be gradually withdrawn with the expectation that the child will continue to dress himself. The same holds true in conditioning a child favorably to the habit of obedience. *It is just as simple to build up pleasant associations around obedience as it is to build up unpleasant ones around disobedience, and after such conditioning the child should continue obedient as a matter of course.*

There were, of course, frequent failures, especially in the early stages of learning, and the reactions of the children after such failures were most interesting. Dick stamped his foot and banged the box into place. Bobby said, in a most disappointed tone, "Ooh, no cookie!" Tim turned and left the room without comment, but then mistreated his playmates on regaining his group. Close observation showed that after successful performance Tim was very congenial and amenable, but after failure he became quite obstreperous.

Mothers and teachers are familiar with those occasions on which everything goes wrong for certain children. They are cross, impatient and ill-tempered. The cause, of course, may be physical, but it may also be a mental set acquired through failure earlier in the day. Children like Tim may go to school feeling disgruntled by an incident which occurred at home, or may come home aroused by an unpleasant incident which occurred in school. Failures, like other unpleasant incidents, are easily forgotten by the young child if followed by success, and thoughtfulness on the part of an adult can frequently arrange such an order of affairs. *It is only fair for those who handle children at least to save the pleasant incidents for parting, and to send the child happily to his next task.*

These incidental suggestions as to child behavior, imparted by the above studies, confirmed our expectation that from the slowly developing idiot child

we could obtain many valuable suggestions for training of both the idiot and the normal child. The field has now been entered, and there is no limit to the research which may follow. Studies of the types and effectiveness of incentives, the frequency and importance of certain personality differences, the relation between learning and extraneous factors in the environment, the results of experience and many other influential factors which efficient training must take into account, may follow these suggestive experiments in the field of idiocy.

CECELIA G. ALDRICH.

A Thumb Sucking Cure

THE problem of thumb sucking arose early in the life of my infant daughter. I recorded its progress and the results of attempts to cure the habit.

The sucking reflex was marked from birth. On day 18 I noted, "It strikes own fist, sucks it. Sometimes sucks breast and thumb or finger at feeding, until finger removed by mother." Progress toward the habit continued. Day 32: Sucks fist when hungry. 59: Sucked thumb when lost nipple. 64: Sometimes sucks thumb or one finger if lips strike it. Left hand in particular.

At this time I consulted Dr. Ethel Waring of the Cornell Nursery School, who advised me to make sure there was no nutritional defect, and to pull out the thumb, saying "Out," whenever it was inserted. My physician assured me that no nutritional accompaniment was evident. Later, however, we discovered that the child was overfed in amount and richness of milk. Eczema developed, and was entirely cured only by omitting cod liver oil and, after weaning, by giving skim milk.

Day 71: Sucks left thumb at times when hungry. Mother pulls out and says "Out." Gives left hand a ring to hold, or turns baby on right side. Baby often cries, throws left hand around. Has never sucked right thumb when observed. 78: Twice when sucking thumb, has pulled out when mother said "Out." Otherwise, has needed to have it taken out. 85: Right thumb now sucked when left tied up. Right sometimes tied up also. 99: Still sucks left thumb at times, but less often. Verbal "thumb out" will usually bring results if command given by mother, then toy handed to baby. 104: Thumb sucking less marked. Handles toys more and more during waking time. 124: Command "out" always brings thumb out. When approved by "good girl," baby smiles or laughs. 140: Thumb sucking only when sleepy, usually at night. Never takes out at command of person other than mother. 157: Pulled thumb out when father said "Out." 184: Took thumb out when Mrs. N— had said "Out" six times.

Thus, at six months, the night sucking remained a problem. There were occasional reversions during the day also, notably during weaning and at the appearance of teeth. Day 267:

The "Out" has become a game, the baby putting her thumb into her mouth and waiting for the command, then laughing as she responds. 290: Removes objects other than thumb at command "Out." Seldom seeks hands, which are covered, at night.

At one year the cure seemed almost complete. However, as warm weather made covered hands uncomfortable, they were again left uncovered during sleep. The habit was at once resumed. At one year and two months the baby was taught to cross her arms while going to sleep. I praised her when she crossed them, in imitation of myself. This made a game of the act, and I insured its continuance by staying beside the baby until she was asleep. For months, there remained a tendency to slip the thumb in at the moment of going to sleep. At one year and five months, the hands were again covered at night, as the weather was cooler. Two months later I noted that "I have not observed thumb sucking for two weeks, even when hands uncovered one warm night."

The habit has not reappeared, and is, I trust, fully overcome. The child is now three and a half years of age. Her teeth have been pronounced perfect by a dentist. She has slight adenoids, with a tendency to mouth breathing. They developed subsequent to the cessation of thumb sucking, and are not attributed to the habit by the examining physician. The callous which developed on the thumb disappeared readily, and the shape of the thumb is normal. The reader will note that the really effective method of handling the problem required the child's coöperation. The covering of the hands aided when she was asleep and unable to inhibit the action.

I may add that my second child, now one year old, has never contracted the habit to such a degree, although she has required constant discouragement. In her case, similar overfeeding at an early age was adjusted. For a short time, at about six months of age, she tended to suck the index finger of her right hand and still, if hurt, sucks this finger momentarily. She also tries at times to insert the finger into her mouth while going to sleep, ingeniously wriggling it through the neck of her sleeping bag. This is particularly true during periods of teething. She associates "out" with all forbidden things put to the mouth, rather than with the finger alone. I am now teaching her to hold a large doll in her arms while going to sleep—a variation of the arm crossing. Two other mothers to whom I related my experience found this an effective cure, as I did.

Florence W. Hazzard

A Study of the Development of Motor Coördination in an Infant Between the Ages of Fifty-eight and Sixty-seven Weeks

PROBLEM

THIS study was undertaken in the hope that the observers might be able to trace the stages of progress toward walking and the subsequent perfection of the coördinations involved in walking, in the case of a girl who was enrolled in the Vassar College Nursery School.

PROCEDURE

The development of motor coördination in an infant from the fifty second to the sixty eighth week of her life was studied by three observers. Running accounts of the motor activities were taken for at least one hour every day of her attendance at the Nursery School. In the report, the biographical data were divided into weekly levels, with significant notes from each week, to show the development of motor traits.

RESULTS

Pre-walking stages

The pre-walking stages include crawling and standing, as well as walking with help. Observation of the subject began in the fifty-fourth week of her life. At this time she was crawling and walking with help, though not very spontaneously, as the notes will show. She was also beginning to pull herself into a standing position. With constant improvement in coördination, this stage lasted until the beginning of the fifty-seventh week, when the subject took her first steps alone. Through the notes, divided into weekly levels, can be traced the sequential development in motor control which leads up to walking.

54th week

October 4. Crawled, pushing with right foot and left knee, one-sided. Reached for end of bed, sitting far from it. Pulled herself up steadily but let go immediately and sat down.

Allowed to walk into the bathroom holding on to adult's hand; steps short, legs spread far apart and swung from the hip, with almost no knee flexion. Feet flopped on floor, very flat.

October 7. T. stood her on feet on floor; she collapsed to sitting position instead of trying to walk. Began crawling, sometimes up on both feet and hands, feet walking and legs stiff, hips high.

T. stood her on floor. Crawled about four feet to a table. Pulled herself up by rolling over onto left knee, planting right foot, reaching edge of table with both hands, and pulling left foot coming into standing position last. Stood at the table a minute, feet wide apart, on their sides, toes curled. Took sideways steps. Crawled about ten feet to the playhouse and back again, alternating knees and feet. Crawled about fifteen feet to the toilet room, last half on hands and feet.

October 8. Pulled herself up to standing position with one hand. Outside, Miss W. took a yellow pan and held it out to M. H., then walked a little way from her, and she crept after, reaching for pan. If she got too far away, she lost interest.

Crawling after pan, she waddled on all fours, neither knee touching the ground. After crawling she sat down on left side first, because she used that side more in pushing when crawling.

October 10. Toes turned slightly outwards and body bent forward from hips when standing at a table. Crawled about with a cup in one hand, a plate in the other.

55th week

October 14. Crawled all the way into the bathroom on hands and feet. Sat still a great deal today. Later, refused to walk when held up. Shoes put on her today. From sitting position she flopped over to creep, but lay down flat. Later, drew feet and knees up and started creeping.

October 15. Walked along table leaning on it. Put feet together, then swung one foot out from hips, wide base.

56th week

October 21. Crawled up the long flight of steps on hands and knees. Same technique as in crawling, right side leading. Seemed tired as she reached the top. Crawled down steps almost backwards, getting on all fours sidewise, on each step. Crawled on hands and feet almost all the time during day.

October 22. Activity great and varied. Crawled upstairs, then across the big room. Followed Miss R around the room. Attention diverted to the children, and sat watching them. Pulled herself up at various tables, etc.

October 24. Very active. Outside, didn't stay on mat. Tried to crawl up a board and did so, with help. A ladder was lying on the ground. She climbed across it, then half the length, falling between the rungs.

57th week

October 29. Crawled quickly away, on feet, from toy. Quick back again. Picked it up in left hand, pushed it in front of her as she crawled. Got all mixed up in it.

Was picked up, put in front of doll-carriage, held from behind. Walked about twenty-steps—short steps, fairly narrow base, bending back and forth at the waist as she lost her balance. T. let go of her; she went two or three steps alone, acquired too much momentum, and toppled. Later, crawled all the way from the big room to the piano. At the piano, grabbed the leg from the foot-crawling position without use of knees, stiffened legs and got up.

October 31. Got going so fast on her hands and feet that she often slipped and fell on her stomach. Explored a great deal today, walking and crawling all around in behind piano. Slid a large block across the floor for about five feet. This required a considerable amount of push in the legs, and coordination of arm and leg movements.

Miss T. came to get her for washing. Said, "Come, baby." M. H. put up her arms; no results, so she crawled over.

Stood up for a second unsupported, then fell to a sitting position.

58th week

November 4. Stood by a chair, reached for toy I was playing with. Stood without support, wobbled and fell.

Positively running across the floor on hands and feet, arms and legs straight and stiff.

Very active this morning. Method of pulling self to standing position: squatted on both feet, pulled with right hand around leg of table and pushed with feet. Once on her feet, let go with hands, stood a minute alone, before putting hands on chair to walk around.

Stood with one hand on the arm of a little rocking-chair, rocking it gently to and fro. Showed great degree of balance by this.

Stood alone in middle of floor; waved arms with delight, but no steps.

Another time she was picked up and set on her feet and willingly started out walking. With support, went half-way across the big room. Feet well planted, far apart, and legs rather bowed, steps uneven and lurching. When support left her, she stood with arms out, fingers stiff, with very little swaying. Seemed just about to take a step. . . . dropped on the floor and crawled away.

Walking around between piano and piano-stool, holding on with first one hand and then the other, but quite casually. Hard to tell whether or not some of the steps were without support.

This was the day before M. H. took her first steps. It was a particularly active and significant day. This day and the days immediately preceding it showed a culmination of all the motor activities in the pre-walking stage. In the fifty-fourth week, pulling herself to a standing position was a long and difficult process. The amount of crawling done was small and covered short distances. An unwillingness to walk was shown on many occasions. In the fifty-fifth week, appeared the ability and desire to walk along the edge of a table. The proportion of crawling done on hands and knees became increasingly smaller during the fifty-sixth week, activity increased. By the fifty-seventh week, a great desire to walk with support was present. Skill in raising and lowering herself increased. Her hand and foot crawling method was improved so that speed was possible. Finally, in the beginning of the fifty-eighth week, standing alone was accomplished. She walked independently about from place to place, holding on to anything convenient. This activity almost entirely replaced crawling.

Walking

57th week

November 5. Walked for first time alone. Took three steps. Could almost run on her hands and feet. Pulled herself to a standing position with great ease and almost entirely with one hand. Could stand easily from sitting position on the floor by first kneeling, then standing on her feet, then pushing the rest of her body up by her hands.

November 6. Took fourteen steps alone.

58th week

November 7. Climbed over toy stove with hands holding onto toy bureau. First put one leg over the stove, then astride it, then after several attempts lifted other leg over.

After standing a long time looking at the fish bowl, she took two steps *backward*.

November 8. After lunch she crawled from the table to the doll's bureau in the playroom—about twenty feet—and then stood up by the bureau. She still found crawling a surer means of getting somewhere.

November 11. After lunch walked about fifteen steps twice with falls in between. She could stagger and catch her balance without falling. Her falls were abrupt, sometimes forward, sometimes backward. She held her arms up and forward as she walked. After becoming more accustomed to walking, she took thirty-nine steps, walking about twenty feet to her mother. She kept her eyes fixed straight before her on the object for which she was walking. Her legs were far apart feet picked up fairly high, steps not perfectly even.

59th week

November 13. Difficulty in walking after sitting down to eat. Dropped to her knees, crawled a few steps, then walked across the dining room. Then crawled a minute. Really walked very fast across playroom and then crawled very fast. Held cup in each hand when walking.

Legs held wide apart. Feet were not lifted very high and knees not bent. Her arms were held in front of her.

Had difficulty walking on rubber matting, because feet did not slide. Tried to look up at the light and fell backwards.

November 18. When walking slowly, sometimes put her left arm down at her side, instead of holding her hands forward.

E. took her by one hand and walked so fast that she practically ran for about five steps. Then she fell down flat.

Could turn quite slowly without losing her balance. Fell with less of a thump and in a more controlled way.

November 19. Was having bloomers put on, stood on the table with hands against wall and balanced first on one foot and then on the other. She clung to the table with her toes.

Almost ran three or four steps at a time.

Did not lose her balance when J. T. put her arms about her.

Stepped over P. G.'s leg without falling down.

Reached down and picked up something from the floor without losing her balance.

60th week

November 21. Had great difficulty in walking and even standing, with big blue sweater and leggings on.

Attempted to run away from some of the children, but lost her balance after running only about three steps.

November 22. Side-stepped in walking to keep her balance, showing greater *coordination*.

November 25. Pushed doll carriage with one hand.

J. H. walked by her very fast, and she lost her balance and fell. She was not yet perfectly sure of herself. Her feet were closer together and she could walk fairly fast.

Liked to walk in circles turning corners. But sometimes fell as her feet interfered with each other. Walked holding blocks in her hands.

61st week

December 21. Practically ran across the room to one of the teachers holding her arms out straight in front of her.

Could turn very sharply on one toe of one foot and did it often.

Tried to climb up on boxes, putting left foot up first, but did not get anywhere and soon gave it up.

Tried to wheel doll carriage and carry a book at same time, but found it too difficult and left the carriage.

Her steps were short; her arms quiet with her fingers spread out.

December 3. In attempting to lean over to pick things up from the floor, she fell over three times, but was successful finally. (On Nov. 10, she had been able to pick things up from the floor with apparently less difficulty.)

Walked with uneven steps, the right leg's swing being longer than that of the left leg. She twisted her body as she walked. Her fingers seemed more relaxed.

December 5. Walked along waving both arms up and down. The right arm went higher than the left and moved more freely.

She showed greater balance and less need of her arms to maintain it.

December 6. Carried book over her head and let it hang down her back.

63rd week

December 16. Walked for a long time holding a small cup in each hand. Then tried to pick up book from the floor, but found she could not with cup in hand, so left cup on floor.

Did not dare to get down from chair without help.

Legs wide apart when she got up from floor to a standing position but got them nearer together when walking.

December 17. Spun half way around quite fast on one foot.

December 19. Scuffed a little with her heels as she walked. Ran up to door and hit it so hard in her attempt to get it open that she bounced back and sat down.

66th week (after vacation)

January 8. Steps very short and feet close together.

January 9. Arms swung freely at sides, legs closer together and feet near ground,—not held high.

During the vacation period a decided advance in her walking ability could be noticed. It was a free, easy step and not the more staggering uneven steps that she had usually taken before.

Climbed up on a chair, first putting up one foot, then the other, helping herself by the table. *Finally* she stood up in the chair, but almost immediately fell over backward onto the floor.

This is the first time the observers had seen her climbing. The chair was a really high step for her.

67th week

January 13. Walked around holding a piece of wood in each hand, then took them back to where they belonged.

She stepped over a door sill with comparative ease. She had a real knowledge of distance and heights now.

68th week

January 16. Walked with her two arms straight up in the air with the forefingers pointed and looked straight up above her—or even up and slightly to the side, but found this too hard and lost her balance. Her walk was still scuffling, sometimes with the heels and sometimes with the toes going down first.

At the age of sixteen months M. H. was able to accomplish the following tasks assigned to the level of eighteen months in the Gesell normative summary: walked alone; climbed chair or stair.

DONALDINE DUDLEY,
DOROTHY DUNCAN,
ESTHER SEARS.

A Study of the Effect of Daylight Saving Time Upon the Sleep of Young Children

PARENTS and teachers have a general impression that the change to daylight saving time causes loss of sleep among children. This loss may be due to the fact that many parents allow their children to stay up later during the daylight saving period than is customary in standard time; or it may be due to the fact that children, whose parents wish to maintain the established routine by putting them to bed the same hour daylight as standard, lie awake longer in the daylight saving time period. Due to the extra hour of light parents feel that the children lie awake; and in cities and towns noises from the street, especially of other children playing, are thought to be disturbing factors. In an institution for children, on the other hand, the bed hour is seldom changed, and the number of outside distractions is reduced.

PURPOSE

In order to determine whether the actual sleeping time of young children is decreased during daylight saving time as compared with standard this study was made in an institution. It was felt that in such a situation many variable factors which might be found in a home study would be eliminated and the factor of increased light would be the only change.

Five girls and 8 boys were chosen as subjects. They ranged in age from two to five years. With one exception, all had been in the institution long enough to be accustomed to the routine.

The room in which the subjects slept was long and narrow, about thirty-seven by fifteen feet. The five windows faced east. These had heavy green shades and outside blinds. The beds had five inch cotton mattresses, with ordinary stretch springs, and crib sides. Each child had one heavy woollen blanket, one lighter weight gray double blanket, one extra blanket and one blanket across the bed which was used to keep the other covers in. Each child slept in flannel pajamas or

night gown. The fourteen beds were arranged down the long sides of the room. The amount of light reaching each bed varied but since the children slept in the same places throughout the study, the light factor was constant for each child; it varied only with the weather and with the change to daylight saving time.

METHOD

Twenty-six observations were made in all. Half of these observations were made during standard time and the other half during daylight time. The period of observation began April fourteenth and ended May tenth, 1930. The children were put to bed at 7:00 p.m. and were awakened at 6:00 a.m. The observer went to the institution daily at 6:30 p.m. and at 5:30 a.m. The following data were recorded daily for each child:

1. Time asleep.
2. Time awake or awakened.
3. Louid noises outside and inside the children's room.
4. Disturbing situations such as visits from older children or punishment.
5. Approximate time at which darkness was complete.
6. Arrangement of the window shades.
7. Ventilation of the room.
8. Approximate temperature indoors and out-of-doors.
9. Weather conditions.
10. Changes in number of blankets used.

The children were not allowed to talk while undressing so that the room was quiet the half-hour preceding the bed time. The four children suffering from enuresis were wakened at a definite time each night to be put on bed pans.

In order to eliminate the personal factor of an outsider as much as possible the observer entered the sleep room at 4 minute intervals. The rounds were started four minutes after the day nurse had left the room and were continued thereafter until all the children were asleep. A final visit was made 4 minutes after the last child was asleep. Sometimes, when the observer felt that the children were waiting for her to return, she allowed 8 minutes to elapse between visits.

An Ingersoll watch was used as the timepiece. In order to keep it accurate it was set night and morning by a Naval Observatory-Western-Union Clock.

The criteria used for judging whether a child was asleep were as follows:

1. Eyes closed.
2. Few gross movements.
3. Steady breathing.

If the child appeared to be asleep, the time was recorded. On the next round this record was checked.

RESULTS

Table 1 shows the number of minutes of sleep per night per child and the average for the group of the number of minutes of sleep per night.

Table 2 shows the average number of minutes of sleep for each of four periods. Subject M was not in the institution during the first period of six nights. During the second period of five nights and the third and fourth periods of six nights each, Subject M was present. The first two periods

TABLE 1

Actual number of minutes of sleep per night per child

NIGHTS	SUBJECTS												AVERAGE
	A	B	C	D	E	F	G	H	I	J	K	L	
1	660	666	655	665	664		653	691	657	656	655	652	061.27
2	638	675	638	675	657		637	061	677	673	675	080	062.27
3	640	675	671	674	654		660	652	670	682	676	660	064.90
4	015	650	634	643	655	633	636		006	645	653	049	043.54
5	630	642	620	645	015	040	636		642	645	652	045	038.00
6	045	660	620	633	623	639	639		045	666	061	062	043.90
7				No observations made									
8	637	647	628	658	647	639	636		647	655	643	651	644.27
9	643	655	638	655	647	661	658		645	663	652	061	652.54
10		640				640	630		652	637	041	650	641.00
11	644	603	630	659	665	646	645	626	667	608	661	660	652.75
12	640	656	640	646	653	642	568	639	658	650	657	658	643.50
13	578	505	592	600	597	598	592	507	594	603	590	597	591.58
14	641	649	608	661	653	656	662	650	604	667	677	650	652.16
15		602		606	602	604	644	672	656		651	664	600.11
16	591	652	584	655	606	657	658	650	652	601	637	654	638.08
17	612	661	612	644	637	653	659	652	654	671	650	603	650.54
18	619	603	626	607	660	666	612	651	606	654	626	658	640.90
19	628	660	620	620	612	658	610	629	654	667	659	661	639.83
20	655	659	638	664	652	666	648	672	608	670	652	662	658.83
21	644	658	630	674	675	668	635	668	670	670	667	670	660.75
22				No observations made									
23	646	655	618	659	644	656	610	612	603	664	644	654	643.75
24	635	660	628	648	640	663	642	636	667	645	642	663	647.41
25	637	653	621	656	642	652	616	614	650	660	642	655	641.41
26	636	644	591	640	634	633	591	609	647	653	644	646	630.66

TABLE 2

Average number of minutes of sleep per period

PERIOD	AVERAGE	
1	652.30	Standard time
2	647.18	
3	647.86	Daylight saving time
4	647.13	

were at standard time and the last two were at daylight saving time. Since M was not habituated to the routine, records of his sleeping time were omitted.

TABLE 3

Differences given in minutes or parts of minutes

The difference between the first and third periods is 4.44 minutes

The difference between the second and fourth periods is 0.05 minutes

The difference between the first and fourth periods is 5.17 minutes

The difference between the second and third periods is 0.08 minutes

The difference of 5.12 minutes between the first and second periods shows that any disturbance caused by Subject M was negligible.

CONCLUSION

From the data collected the observer concludes that in a situation where a constant routine is maintained the total night sleeping period of young children is not affected by daylight saving time. Thus it would be possible for parents who find their children are losing sleep on daylight time to make up for the loss by increasing the children's naps during the day or by maintaining the same routine during daylight saving time as during standard time.

MARGARET REESE.

The Effect of Group Training Upon the Correction of Articulatory Defects in Preschool Children

AGNES THORVILSON SOMMEN[1]

SPEECH development in young children has received much attention from investigators of child behavior since the beginning of the century. In recent years the biographical records of vocabulary growth have been supplemented by systematically controlled studies of vocabulary, sentence length, and parts of speech, on large groups of children. Among these the works of Bateman (1), Smith (21), and McCarthy (14), have added much to our knowledge of language acquisition.

The articulation phase of speech, however, has been neglected in the preschool years. Surveys on large numbers of school children at various ages from kindergarten to college, conducted by Wallin (29), Root (19), Blanton (5), Conradi (10), and Stinchfield (25), indicate that a considerable percentage of the school population possess speech defects. The estimates range from 2.46 per cent (Conradi) to 19 per cent (Stinchfield); but in general the authors agree that the percentage of defects decreases from kindergarten on. These investigators and others interested in corrective speech education agree that training in articulation should begin in the primary or early elementary grades. Wile (32), Brigance (8), Martin (5), and Case (9), all state that corrective training should be instituted in the plastic years of early childhood, and place the emphasis on the early school grades as the most practicable time and place for speech instruction. The statements of Gesell (12), Stinchfield (22), and the Blantons (4), however, indicate that these authors consider the preschool years as the most fruitful training period. Logical and reasonable as these opinions are, they as yet lack the support of experimental studies.

In a study of 172 pairs of lispers in grades 1 to 12, Berry and Stoddard (3), found improvement in 98.3 per cent of the experimental group and in only 45.3 per cent of the controls after training. Improvement was apparently little related to intelligence, age, home language, and sex. The correlation between extent of defect and amount of improvement was positive. A recent study of speech sounds of children from two to six done at Iowa (31) revealed that at three

[1] From the Institute of Child Welfare, the University of Minnesota. Condensed for periodical publication by Mary Shirley.

years each consonant blend was given correctly by at least 20 per cent of the children, each consonant element by 30 per cent, each vowel by 60 per cent, and each diphthong by 70 per cent. By five years the percentages had increased respectively to 40, 40, 70, and 80. A high correlation was obtained between age and correctly given speech sounds; the relationship remained high when mental age was held constant.

From this brief review of the literature it is evident that more experimental work on articulatory defects should be done at all ages, and particularly on the preschool child.

PURPOSE

The purpose of this study is to determine to what extent preschool children with articulatory defects who are given group corrective speech training improve as compared to similar preschool children who are given no training. A secondary purpose is to learn how such improvement may be related to factors other than training, such as chronological age, I.Q., sex, school attendance, paternal occupation, and education of the parents.

SUBJECTS

A total of 34 nursery-school children, ranging in age from 26 months to 59 months, and 27 kindergarten children, ranging in age from 57 months to 67 months, were tested for articulatory speech defects, and from these two groups, the subjects used in the experimental group for this study, together with their paired controls, were drawn. The children were enrolled in the nursery-school and kindergarten of the Institute of Child Welfare, University of Minnesota.

TEST USED

The Blanton-Stinchfield Speech Measurements (6), Articulation Test (A-No. 1) Part II was adapted for use. In some instances, it was too difficult for the younger nursery-school children, but with slight modification, was made applicable. The test consists of charts, about 9 x 11 inches, on each of which are 9 pictures of familiar physical objects and animals. The child is asked the question written under each picture, the answer to which contains the sound being tested for, in its desired position, initial, medial, or final, and in strong form. The 21 consonants, 3 nasals, and 1 glottal aspirate defined by the International Phonetic Association, together with 10 blends, or double consonants were tested for in this study. Including the 3 positions (initial, medial, and final) in which most of the sounds were tested, the test altogether consisted of 75 different sound items. No vowels were tested for.

Because many of the pictures were beyond the level of the children, especially the younger nursery children, other stimuli were substituted if the child did not respond to the question in regard to the picture being shown. For example, a zebra is shown to elicit the initial sound "z." Since very few children recognized the animal, it became necessary to get the sound either by imitation (a method resorted to as infrequently as possible, and when used, care was

taken that the mouth of the speaker was not visible to the child) or, by talking about overshoes, and finally, after endless questioning, getting the response, "zipper."

TESTING PROCEDURE

The children were tested individually in a quiet room free from distracting stimuli. An assistant[2] trained in speech work elicited the sounds from the child; and the sounds were recorded independently by the author and J. Roderic Springob, who also used the material collected in his research work. The sounds were recorded on a blank containing the conventional phonetic symbols for all the sounds in their three positions. The symbols decided upon by the International Phonetic Association were used; for purposes of publication they have been converted into their English letter equivalents. Notation was made in three terms, sounds correctly given, sounds omitted, and other sounds substituted for the correct sounds. Doubtful cases were tried a second time with another stimulus word if necessary. For example, a picture of a tree was given to elicit the initial "t." A few subjects who were unable to make the "t" because of the "tr" combination did make "t" in "toe" or "tie." With the younger children the testing procedure was sometimes shortened by checking sounds other than those being tested for at the moment. For example, in testing "h" in hat, the final "t" might also be checked; in cases of doubt it was rechecked by the regular stimulus word.

All the children were tested originally in December 1929 and January 1930 and were retested in April and May of that year. The mean time required for testing both nursery school and kindergarten groups was 25 minutes; and for retesting, 20 minutes with the younger, and 18 with the older group.

The reliability of the simultaneous record taking of Sommer and Springob was extremely high. Correlation coefficients for the age group from 26–46 months were .98 ±.003 for test and .99 ±.004 for retest; and for the 47 to 59 months group were .99 ±.003 for both test and retest, there being 17 cases in each age group. While these coefficients are extremely high, it must be pointed out that they represent only the agreement between the two raters in respect to the total number of defects and do not take into consideration which sounds were substituted for or omitted.[3]

PAIRING

The experimental (or training) groups and the control groups were drawn from all the cases who had been judged by the writer to have three defects or more. Three defects were arbitrarily decided upon as the dividing line, because they gave us enough subjects for the experiment, while a higher number of defects would not.

[2] The writer wishes to thank the assistants, Margaret Blanford and Helen Thorvilson.

[3] These coefficients in no sense represent the reliability of the test; and the consistency of the raters might better have been determined by computing the percentage on sounds recorded identically by the two raters. M.S.

However, one kindergarten child who had only two defects was included in the control group in order to be paired with one in the experimental with three defects because she paired best on all the factors upon which the pairing was based.

There were three groups of pairs made:

(1) 11 Experimental nursery children with 11 paired Controls.

(2) 3 Experimental kindergarten children with 3 paired Controls.

(3) 3 Experimental kindergarten children who entered school late, were younger and had only one-half the corrective work which was given to Experimental groups (1) and (2), and their paired Controls. This is called the six-weeks group.

Pairing was done on the basis of (1) speech defects, taking into consideration the omissions and substitutions; (2) C.A. at the first test; (3) I.Q. on Minnesota test; (4) days of school attendance prior to the test; (5) education of the parents; and (6) paternal occupation according to the classifications based on the Barr scale of occupational intelligence and the Taussig industrial classification, which have been revised for the Minnesota population (13).

Table 1 shows the closeness of the experimental and control groups in the various factors on which they were paired. Although the pairing was not perfect in every detail, yet the two groups were as nearly equal as the small number of cases permitted. In all cases speech defects were considered the most important item in the pairing.

THE CORRECTIVE PROGRAM

The corrective work, with the exception of the 3 younger experimental kindergarten cases who entered late and were given just one half the work of the nursery and older kindergarten, was begun in January and continued for 12 weeks. For convenience the nursery group was divided into two, an older and a younger which were given 15 minutes each day. Both kindergarten experimental groups were also given 15 minutes a day, 5 days a week.

On account of absences and holidays the children who were trained for 12 weeks did not receive 60 days of work; nor did the 6 weeks children have 30 training lessons. The mean number of training periods for the nursery school groups was 38.7, for the older kindergarten 47.0, and for the younger kindergarten (6-weeks group) 22.0.

The training was given by the writer who had been trained in speech correction but who had never before taught a class of preschool children. In the two nursery school groups there was always a practise teacher assisting. The corrective period was called "games" by the nursery school and kindergarten teachers who coöperated most helpfully in trying to build up in the children pleasant associations with the experimenter and with the speech period. The class usually started with a relaxation exercise, the children's favorite being, *The Land of Noddy-Pod.* The following verse was repeated softly and slowly by the

teacher while the children performed the actions.

Softly we will rest,
In our little nest,
Put away our feet (cross feet)
Tuck around the sheet (arms folded)

After the relaxation the remainder of the period was spent in games, dramatizing nursery rhymes, and doing simple action, voice and tongue exercises. The source of many of these was Barrows and Case (2).

TABLE 1

Closeness of experimental and control groups after pairing

PAIRING FACTORS	NURSERY SCHOOL GROUP		KINDERGARTEN GROUPS* (Older)		KINDERGARTEN GROUPS* (Younger)	
	Experimental	Control	Experimental	Control	Experimental	Control
Speech defects:						
M.	16.46	15.36	14.67	12.33	14.33	13.67
S.D.	13.31	9.10				
C.A. at date of 1st test:						
M.	43.00	42.73	64.00	62.33	60.00	58.67
S.D.	5.98	7.70				
I.Q. (Minnesota):						
M.	120.54	115.73	101.67	110.00	109.00	108.00
S.D.	14.69	7.22				
School attendance prior to the test (days):						
M.	140.00	143.82	66.33	212.67	39.00	44.33
S.D.	96.84	85.58				
Education of the parents (years of father plus years of mother):						
M.	25.64	26.00	18.50	20.42	31.00	26.33
S.D.	4.92	7.84				
Paternal occupation:†						
M.	2.46	3.00	3.33	2.67	2.33	2.67
S.D.	.99	1.35				
Number of cases	11	11	3	3	3	3

* Standard deviations are omitted on the kindergarten groups because of the small number of cases.

† Average parental occupation was computed by assigning an arbitrary weight of 1 to occupational class I; 2 to occupational class II, and so on.

Snug as a pea in a pod
With a yawn and a gap (children yawn)
And a dreamy little nap (close eyes)
We will go, we will go
(repeat very softly)
To the Landy-oddy-oddy,
Of the Noddy-oddy-oddy,
To the Landy-andy-andy-andy
Of Noddy Pod.

Some of the exercises were the windmill game wherein the children made the "th" as in *this*, accompanied by waving of arms like windmills; animal sounds such as s-s-s-s-s (goose), z-z-z (bee) and engine and machinery sounds such as tch-tch; and the old-

time favorite "Here we go round the Mulberry bush." The remainder of the training consisted of word drills. In all the games the experimenter enunciated very clearly and exaggerated slightly her lip, tongue, and jaw movements. Occasionally a direct reference was made to the defective sound of an individual child, but the usual procedure was group practice on all sounds made incorrectly by children in the group.

From the second week of therapy on, small hand mirrors were used for 5 minutes at a time, one or two days a week. Apparently they helped some in the kindergarten group, but they were not so satisfactory as a large mirror in which both children and teacher can look at once. The small mirrors encourage "fooling" and make it difficult for the child to shift attention from the teacher's mouth to his own.

The first improvement noted was in a boy, who on the fifth day learned to say the initial "th" sound as in *thumb*. He was very proud of his accomplishment and for at least two weeks, whenever another child was being corrected, he would say, "I can say "thumb" can't I, Mrs. Sommer?" The "v" sound was corrected early in many children. A Valentine was promised to everyone on Valentine's Day who could say "Valentine," which may partly explain their early correction of this sound. However, another reason seems to be that it is a sound, the making of which is easily explained: "Let's bite our lower lip, children." This is also true of both "th" sounds; "Let's put our tongue between our teeth." All the children were very proud of their corrections accomplished and tried to out-shout each other as to what they could say *now*.

Sitting-down exercises and games were alternated with standing-up and running games to provide frequent change, stimulation, and to keep up interest. This was especially true in the nursery groups in which there were difficult children whose occasional unwillingness to come with the group and whose unwillingness to coöperate in the group were a constant source of difficulty to the assisting teacher and the writer. However, that their behavior was similar outside the speech class was a fact which prevented the writer from feeling too much discouragement. In spite of the behavior difficulties, one of these children improved 82 per cent.

It might be interesting to state here that of the half of the experimental group (12 weeks) who improved most, all but one (the one just referred to who improved 82 per cent) were considered by the writer to be the most coöperative and interested of all the children.

ANALYSIS OF RESULTS

Inasmuch as the means of Springob's and Sommer's test judgments are the figures used in this study as the measure of the child's defects on the first test and on the retest, it might be well to justify such treatment at this time on the basis of an analysis of the independent judgments of the two testers. Such justification is necessary, at least for the use of the mean measure on the second test, because any prejudice of the writer on this

test in favor of the experimental group and to the disadvantage of the control group, would invalidate the use of her test results. It is also possible that Springob, who assisted in the pairing might have been prejudiced in the other direction on the retest; although at the retest he had forgotten most of the children who had been placed in the training group, he did remember a few cases.

TABLE 2

Comparison of the test results of Sommer and Springob

	SOMMER DATA				SPRINGOB DATA			
	Defects		Improvement on defects	Per cent improvement	Defects		Improvement on defects	Per cent improvement
	Test I	Test II			Test I	Test II		
Experimental group (17 cases)								
Mean	15.76	6.53	9.24	58.58	14.29	6.47	7.82	54.73
S.D. dis	13.69	8.97	6.41	22.59	11.30	9.04	5.34	26.56
Average of Sommer-Springob:								
M	15.03	6.50	8.53	56.75				
S.D	12.46	8.99		21.41				
Control group (17 cases)								
Mean	14.53	10.76	3.76	25.92	13.88	9.82	4.06	29.24
S.D. dis	9.00	6.92	4.60	25.76	8.45	6.31	4.84	27.10
Average of Sommer-Springob:								
M	14.21	10.29	3.91	27.54				
S.D	8.61	6.59		24.34				

Probability of true differences existing

DIFFERENCES BETWEEN:	D/σ_D	CHANCES IN 100
Sommer Test I and Springob Test I:		
Experimental group	1.99	98
Control group	.96	83
Sommer Test II and Springob Test II:		
Experimental group	.11	54
Control group	2.61	99
Test I and Test II, experimental group:		
Sommer	5.88	100
Springob	5.92	100
Test I and Test II, control group:		
Sommer	3.40	100
Springob	3.90	100
Average improvement of experimentals and controls	2.77	99.7
Per cent of improvement of experimentals and controls	3.44	100.0

Table 2 makes a comparison be-

tween the test results of the two raters. In the original test Sommer found slightly more defects than Springob for both experimental and control groups, but the critical ratios between differences and standard deviations of the differences do not quite meet the usual criterion of significance (3.0). On the retest the two raters disagree even less on the experimental group, but on the control group the likelihood of Sommer's finding more defects than Springob rather closely approaches the significant ratio (2.61).

Both raters find, however, a significant decrease in defects for the experimental group after training; and they also find an almost equally significant decrease in defects for the control group, although the critical ratios are not quite so high for the control group as for the experimental. The agreement between the two raters in all the tests, with the possible exception of retests on controls, is quite high, a fact that lends credence to the results and that in a measure justifies the average of the two raters' judgments in further statistical treatment. From these averages it appears that the experimental group has a percentage of improvement about twice as great as that of the controls (56 per cent and 27 per cent, respectively). In actual elimination of defects the experimental is twice as efficient as the control, (8.5 and 3.9).

Individual records show somewhat more strikingly the effects of training. Three children in the control group failed to improve at all, whereas none in the experimental group failed to improve. No child in the control group equalled the median of the experimental in per cent of improvement, while all 17 of the experimentals exceeded the median per cent of improvement of the untrained. In the untrained group only 3 children eliminated more defects than the median of the experimental, whereas 16 of the experimentals eliminated more defects than the median of the control.

Correlations were computed to show relationship between first and second tests. These correlations, done by the Pearsonian formula, when corrected for regression were:

	EXPERIMENTAL (17 CASES)	CONTROL (17 CASES)
Fewness of errors on Test I with per cent of Improvement...	$+.67\pm.09$	$-.04\pm.16$
Fewness of errors on Test I with Improvement in Defects..............	$-.07\pm.16$	$-.84\pm.11$
Fewness of errors on Test I with fewness of errors in Test II..................	$+.90\pm.03$	$+.86\pm.04$
Fewness of errors on Test I with C.A....	$+.04\pm.17$	$+.06\pm.17$

The correlation between fewness of errors on Test I and fewness of errors on Test II is quite high for both experimental and control groups. These coefficients are virtually measures of the reliability of the test, and they indicate that neither training nor lack of it substantially altered the relative positions of the children in the group with respect to speech defects. The correlation between initial errors and per cent of improvement suggests that in the trained group those with fewer defects improve most, whereas

in the untrained group no relation exists between original status and per cent of improvement. In actual number of defects, however, the untrained groups shows a high negative correlation between initial status and improvement; this means that children with more defects eliminate more than those with few, probably simply because they have more to get rid of. Chronological age showed practically no correlation with initial errors.

Correlations were also worked out between per cent of improvement and the factors of C.A., M.A., I.Q., parents' education, days of school attendance, and days of training. All were low and had high probable errors, so that no significant relationships were established.

Age and sex differences

The fourteen children who had 12 weeks of training and their paired controls were divided into two age groups, from 30 to 46 months and from 47 to 65 months. This division failed to show any significant differences between older and younger groups in per cent of improvement. The efficacy of training was revealed for both age groups, however, in that both younger and older experimentals had a significantly higher per cent of improvement than the younger and older controls respectively.

Sex differences were very slight but rather consistently favored the girls. Both experimental and control girls were somewhat better than boys on the original test, and both groups of girls likewise had a higher per cent of improvement than the boys. For the experimental group the sex differences had a critical ratio of 2.0, thus bringing the ratio close to the margin of significance; in the control group the girls were not quite so superior to boys on the original test and their improvement was greater than the boys by only a little better than chance (critical ratio .79). For both boys and girls the experimental group improved more than the control.

Analysis of improvement by sounds

On the basis of the Sommer records the improvement in sounds for each of the three positions was analyzed for both experimental and control groups. The results for the 14 children who had 12 weeks of training and their controls are shown in table 3. For each type of error, substitutions and omissions, and in each position, initial, medial and final, the experimental group had a greater per cent of improvement. In total substitutions, the experimental group had a per cent of gain twice that of the controls. On the surface the difference between experimentals and controls in per cent improvement in omissions looks even more significant, but it really is less significant because the number of omissions in all cases were few and were confined to a few children rather than distributed among all in the group. With regard to the positions it appears that defects in the initial and medial positions improve about half as much without training as they do with training over a 4½ months period. Errors in the final position are harder to eliminate without training, it would seem, since the control group eliminated 0 per cent of their

TABLE 3

Differences between 12 weeks' experimental and control groups in substitutions and omissions in initial, medial and final positions

GROUP	INITIAL				MEDIAL				FINAL				TOTAL			
	1st	2nd	Gain	Per cent	1st	2nd	Gain	Per cent	1st	2nd	Gain	Per cent	1st	2nd	Gain	Per cent
Substitutions																
Experimental	75	29	46	61	41	24	17	41	62	32	30	48	178	85	93	52
Control	94	59	35	37	43	29	14	33	57	55	2	4	194	143	51	26
Omissions																
Experimental	10	1	9	90	19	1	18	95	18	3	15	03	47	5	42	89
Control	1	1	0	00	8	5	3	38	3	5	−2	−67	12	11	1	8
Substitutions and omissions																
Experimental	85	30	55	65	60	25	35	58	80	35	45	56	225	90	135	60
Control	95	60	35	37	51	34	17	33	60	60	0	00	206	154	52	25

TABLE 4

Differences in improvement of single sound defects, classified phonetically, between the experimental and control 12 weeks' groups

CLASSIFICATION	EXPERIMENTAL (12 WEEKS)			CONTROL (12 WEEKS)		
	1st test	Gain	Per cent gain	1st test	Gain	Per cent gain
Acoustic:						
Atonic	55	40	72.73	64	34	53.12
Tonic	119	72	60.50	92	21	22.83
Anatomic:						
Bi-labial	7	5	71.43	5	1	20.00
Labio-dental	18	17	94.44	6	−1	−16.67
Lingua-dental (pre-dental)	38	30	78.95	55	33	60.00
Lingua-rugal (alvelar)	84	43	51.19	83	21	25.30
Lingua-palatal	5	5	100.00	3	0	00.00
Lingua-velar	22	14	63.64	4	1	25.00
Physiologic:						
Glottal	0	−2	−200.00	0	0	
Plosive	41	26	63.42	24	12	50.00
Fricative	129	84	65.12	132	43	32.58
Nasal	4	2	50.00	0	0	

final errors whereas the experimentals eliminated 56 per cent.

Consonant classification

Using the Borden and Busse three-fold classification of consonants, with slight modifications, the improvement in the two groups was again analyzed. These results are given in table 4.

The most outstanding differences between the experimental and control groups according to the classification just referred to are in: tonic or voiced consonant sounds in which the im-

provement of the former is 60.50 per cent and the latter 23.83 per cent; in lingua-rugal or alvelar consonant sounds in which the experimental with 84 defects on the first test improves 51.19 per cent, while the controls, with 83 on the first test improve only 25.30 per cent or about one-half as much; and in fricative consonant sounds in which the improvement of the experimental group with 129 errors in this category is 65.12 per cent or twice that of the controls who improve 32.58 per cent on 132 original defects. In addition to these three classifications, the experimental improvement in per cent is about 20 per cent more than the control in the atonic sounds and about 19 per cent more in the lingua-dental sounds. These are the only other categories besides those discussed above which have enough original defects in both the experimental and control groups so that a comparison between them is not unreasonable or unwarranted. We are probably justified in saying that corrective work, as compared to no corrective work, with preschool children seems more effective in tonic than in atonic consonant sounds, in lingua-rugal consonants than in the other anatomic classifications, and in fricative than in plosive sounds.

Blends

Table 5 shows some decided differences between the experimental and control groups in their correcting of blends. The blends included in the Blanton-Stinchfield Speech Measurements Test (6) are kl, fr, nk as in bank, pl, fl, gl, tr, br, gr, and lz. While the two groups are practically equal on the Test I with 51 blends defective in the experimentals and 50 in the controls; the former gain 23 or 45 per cent after 12 weeks of training, while the latter not only do not improve but instead add 3 more defects to their original 50, during the period between the two tests.

TABLE 5

The effect of 12 weeks training in the correction of defective blends

GROUP	N	1ST TEST	GAIN	PER CENT GAIN
Experimental.....	14	51	23	45
Control...........	14	50	−3	−06

Omissions

The omissions of five children, three of them experimentals and two controls, who omitted 5 or more sounds on the original test were analyzed to see how they were corrected. Only 11 of the original 96 omissions remained on the second test; 49 had been corrected entirely, but 36,— more than a third, —had merely been changed to a substitution. The child having the most changes from omissions to substitutions was one of the youngest of the group. Her case raised a question in the author's mind as to whether the change from omissions to substitutions might not be a definite step in the development of articulation in young children, a possibility that is suggestive for further study on children between the ages of two and three.

Hardest and easiest sounds

According to Test I, the easiest sounds (those wrongly given 5 times or less) for both experimental and control groups were m, b, h, p, w, t, d, n, ng, and f. The hardest, those given wrongly 15 times or more, were v, th,

(both voiced and voiceless) z, sh, zh, tch (as in watch), j (as in jig), l, and r. These lists of hardest and easiest sounds agree well with those recorded by other observers. The sound most easily corrected by the trained group was v; that easiest for the controls was sh. Both groups improved greatly on both the sounds th and j, but experimentals improved somewhat more than controls on zh, r, and y (as in yellow). Experimentals showed no improvement on pl, b, and regression on h and t; controls showed none on y, tr, fr, and wh, while they regressed on v, s, z, l, t, g, gl, br, and lz. Many of these sounds are on the list of easy ones, a fact which suggests that the easiest sounds to make by the majority may not be the easiest to correct by the minority.

CONCLUSIONS

1. Consistency of the two raters on the speech tests, as measured by correlations between number of errors, was high, +.98. Consistency of the children's scores after a 4½ month interval was also high, +.90 for experimentals and .86 for controls.

2. After a twelve weeks' interval preschool children showed improvement in articulation regardless of whether they have been trained systematically during the interval.

3. Improvement in the trained group was 57 per cent, about twice that of the untrained group, 28 per cent, when gain was measured in percentage.

4. The experimentals exceeded the controls in number of defects eliminated by a difference that was 2.7 times its standard error; and in per cent of gain they excelled to the extent indicated by a difference of 3.4 times its standard error.

5. Improvement was approximately the same for younger and older age groups both of experimentals and controls.

6. Sex differences were slight but apparently favored the girls.

7. Improvement was noted for sounds in all three positions, but those in the final position seemed hardest to eliminate without training.

8. There was a suggestion that original omissions, especially in the younger children, changed to substitutions on the retest.

9. Classification by sounds showed a few differences between experimentals and controls that are interesting from the phonetic standpoint.

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The Latent Time of the Body Startle in Infants*

Orvis C. Irwin

THE data reported in this article are incidental to an investigation of auditory intensity thresholds of eyelid responses, and of the body startle in newborn infants.

The pattern of the *Schreckreaktion* or body startle has been described by Peiper who stated that the whole body jerked together, both arms extended and then returned in a clasp to the trunk, the elbows being flexed. The fingers were first extended, then clinched. The movements of the legs were similar but weaker.

This reaction was first studied by Moro (2) who later used it for diagnostic purposes (3). Watson (7, 8) has interpreted it as the basis of fear in children. Peiper (4) measured the latent time of the body startle in one infant between the second and fourth months and found it to be .25 second, the mean deviation being .067 second. In this study the latent time of 163 body startles in 12 infants varying in age from fifteen hours to fifty-three days has been measured. Six infants were males and six were females. The number of trials from infant to infant was not kept constant.

* From Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

The infant was placed on a two-dimensional stabilimeter within a Pratt experimental cabinet (1). The tone was furnished by a loud speaker placed four inches from the crown of the infant's head. The stimulus was a loud tone of 581 cycles with a duration of .07 second. Its intensity was not measured but was sufficient to cause a startle in adults who were not expecting to hear it. The loud speaker was hooked into the output circuit of a three-stage audio-oscillator. An eccentric on the shaft of a synchronous motor which drove a polygraph controlled both the output of the oscillator to the loud speaker and a pen which recorded the stimulus on the moving tape of the polygraphs. The body jerk of the infant was translated by the stabilimeter to the writing pens of the polygraph, the resulting movement being traced on the moving polygraph tape. The movement of this tape was practically constant, the error being less than one-third of 1 per cent. The distance from the stimulus record on the polygraph tape to the inflection point of the response curve gave a measure of the body startle.

Table 1 presents 163 latent times of the body startle in 12 infants. The

mean latent time is .18 second. These values vary from .07 second to .35 second. The probable error of the distribution is .03 second and the probable error of the mean is .003 second.

TABLE 1

Latent times of the body startle in twelve infants

INFANT	SEX	LATENT TIME (SECONDS)							
1	F.	.349	.156	.180	.261	.144	.144	.240	.156
2	M.	.145	.145	.163					
3	M.	.181	.200	.072	.160	.270	.180		
4	F.	.163	.181	.200	.145	.145	.163	.163	.145
		.200	.236	.145	.127	.145	.163	.145	.163
		.163	.145	.145	.163	.218	.145	.200	.145
		.145	.163	.309	.163	.163	.127	.127	
5	M.	.145							
6	F.	.290	.163	.181	.163	.189	.181	.127	.145
		.181	.109	.145	.145	.145	.290	.163	.181
		.181	.145	.236	.145	.163	.163	.163	.181
		.181	.145	.236	.145	.254	.145	.145	.272
		.145	.145	.290	.345	.127	.127	.254	.163
		.127	.200	.290	.181	.200	.200	.145	.290
		.254	.218	.163	.218	.145	.145	.127	.145
		.127	.181	.200	.266	.127	.127	.145	.163
		.163	.200						
7	M.	.204	.145	.168	.192	.156	.192	.253	.277
		.265							
8	F.	.180	.156	.168	.144	.204	.156	.168	.144
		.132	.156						
9	M.	.218	.127	.163	.145	.145	.236	.218	.254
		.218	.236	.163					
10	M.	.163	.145						
11	F.	.145	.127	.145	.109				
12	F.	.290	.145	.218	.127	.181	.218	.127	
		.109	.254						

Mean	.18
Probable error of distribution	.03
Probable error of mean	.003

(Valentine, 6.) It differs, of course, from simple reactions in that it is an involuntary response. The value with our infants is somewhat less than that of Peiper's (4, 5) who reported it to be

The latent time of the body startle thus approximates the values for simple auditory reaction time in adults. Values have been reported ranging from .149 to .204 second. .25 second on one infant. One of our infants (Infant 12) is comparable in age with the infant whose latent period was measured by Peiper. The value for this infant is .19 second.

The following tabulation shows the mean latent times for each of the 12 infants:

INFANT	SEX	BODY STARTLES	LATENT TIME
1	F.	8	.20
2	M.	3	.15
3	M.	6	.18
4	F.	31	.17
5	M.	1	.15
6	F.	66	.18
7	M.	9	.21
8	F.	10	.16
9	M.	14	.19
10	M.	2	.15
11	F.	4	.13
12	F.	9	.19
Total............		163	

These mean values vary from .13 second to .21 second.

The mean latent times of the body startle by days is given below:

DAYS AFTER BIRTH	INFANTS	TRIALS	MEAN LATENT TIME
1	4	15	.18
2	2	9	.18
3	2	17	.19
4	2	34	.17
5	3	21	.17
6	2	27	.20
7	1	11	.20
10	1	2	.15
11	2	5	.14
14	1	9	.16
18	1	3	.18
53	1	9	.19

The data is more adequate for the first seven days than it is for later days. However, it will be seen that the variations are slight except on the eleventh day due probably to poor sampling on that day.

The following tabulation shows that the mean latent time for six male infants is .19 second and for six females .18 second:

	MALES	FEMALES
Trials....................	35	128
Mean latent time..........	.186	.177
Probable error of distribution....................	.03	.05
Probable error of mean....	.004	.004

There is no significant difference between these values so that it may be concluded that there is no sex difference in the latent time of the body startle in infants.

An interesting observation in this study of newborn infants is that crying never accompanied these body startles to loud tones. On the other hand, eyelid responses were observed to occur even when no other overt response was observable, the lids closing upon stimulation if they were open, or tightening if closed.

The following conclusions may be drawn from these data:

1. The infants responded to loud tones either by a body startle or eyelid responses.

2. The eyelid response (closing or tightening) was observed to occur even when the body startle was not elicited by the loud tone.

3. The mean latent period of 163 body startles following a tone of 581 d.v. with a duration of .07 second made by twelve infants from fifteen hours to fifty-three days old is .18 second; the standard deviation is .03 second.

4. The shortest latent period was .07 second.

5. The latent time of the 163 body

startles (involuntary response) is comparable to that of simple auditory reaction time in adults.

6. There was little change in the mean latent time from day to day.

7. There was no significant difference in the mean latent time of six boys and six girls.

8. Crying never accompanied these body startles.

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Verbalization as a Factor in Learning*

MARJORIE K. PYLES

IN THE present study the problem was to determine the influence of verbal symbols in the development of form discrimination. The method used was to compare children's learning scores on three series of problems of the multiple choice type. In series A and in series B the stimulus objects consisted of five green papier-mâche moulds of the same height (2 inches) and of approximately the same size. They differed, however, in external contour, being modelled in a variety of "nonsense" 3-dimensional forms. Series C consisted of five familiar animals (a cat, dog, rabbit, bear, and monkey). These were 3 inches in height, and were made of celluloid; as the celluloid proved to be too light to withstand daily handling, a filling of plaster of paris was poured into the interior of each object, in order to give weight and stability. In all three series, a cup-like opening was left at the bottom of each object, permitting a small toy to be hidden inside. These toys, serving as reward objects when a correct selection was made, consisted of 25 toy animals, ½ of an inch in height.

[1] This problem was suggested by Professor E. Harold Jones and the experiment was carried out under his direction. Thanks are also due to Dr. Virgil Dickson for assistance in procuring data in the Berkeley Public Schools.

The subjects for the experiment were 80 nursery school, kindergarten and first grade children from the University of California Institute of Child Welfare, the Berkeley Day Nursery, and the University Elementary School. Since in this experiment it was necessary to compare learning scores for three different series of test material, it was deemed advisable to rotate the tests in comparable groups of subjects, in order to control practice factors. With six possible orders of testing (A B C, A C B, B A C, B C A, C A B, C B A) six equivalent groups were necessary; these were obtained by a process of matching, taking into consideration C A., M A., school and sex.

The instructions for series A were: "One of these shapes has a toy under it; see if you can find which shape has a toy." The child's first efforts are of course purely trial and error; after a successful choice, he was asked where he had found the toy. When he indicated the "correct" object under which the toy had been located, the experimenter would say, "Yes, that one had it." This procedure, calling the child's attention to the correct object, was for each series employed on the first three trials, and at every third trial thereafter. The purpose of this was to maintain an interest in "getting it right the first time," and

to counteract any tendency to fall back on random choices. After the first trial, a screen was erected in front of the child, and the five objects were quickly rearranged, a new toy being concealed under the same stimulus object as in the previous trial. The problem was considered solved when the child's first choice was correct in four successive trials. If a solution was not reached in 25 trials, the experiment for that day was discontinued. At the next sitting, the series was reduced to four objects, the previous "correct" object being omitted; if necessary, 25 trials were again given, and at the following sitting, the series was reduce to three, and then to two objects. The number of stimulus objects in the set-up was decreased in this manner because it was believed that the frequency of complete failures, at the lower age levels, would be reduced by this procedure, while with the older children adequate differentiation would still be maintained. As far as possible, tests on the same series were made two days apart. Two weeks after the completion of a given series (with a maximum of 100 trials on four different days) the child would be started on a second series, according to the sequence (ABC, or CBA, etc.) prescribed for his particular group.

In Series B the same procedure was followed, except that the child was encouraged to verbalize his successful performances, through the use of a name for the "correct" object. After the child found the toy on his first trial, the experimenter asked where he had found it, and then said "The name of that shape is Mobie." "Can you say that?" "All these things have different names. I'll tell you their names." The names given the five shapes were Mobie, Kolo, Tito, Gamie, and Bokie. The "correct" names were rotated, and the actual objects employed in Series A and B were also rotated, so that the average difference between these two series would be wholly one of procedure. Care was taken to insure that the actual amount of time spent on the named series (due to the naming process) was not greater than that spent in pointing out the objects in the unnamed series. In Series C (familiar animals) the children usually named the animals spontaneously; if they did not do so, the name was supplied by the experimenter in the first trials.

A record was kept of the objects picked up on each trial, the verbal responses and remarks made by the child, and his attitude toward the task.

RESULTS

The relative difficulty of the animal, named and unnamed series is indicated by the comparison of the learning scores shown in table 1. The scores compared are those obtained by the children on the learning problem they were given first. The mean and median number of trials required for the solution of the three problems are given, and the percentage completely failing each problem. It is of interest to note that practically all the children solved the animal problem in less than twenty-five trials (i.e., with five stimulus objects in a set-up) whereas 42 per cent solved the named and only 4 per cent the un-

named series within this number of trials.

The solution of the problem in each of the three series is dependent on the child's realizing that the toy is always under the same object, and his being able to recognize the "correct" object as such from among the others. After a child has solved one of the problems, he knows on the two succeeding series that the toy is always to be found under some one object. It is therefore to be expected that the scores obtained on the series given first to a group would be higher than the scores of the same series when given second or third, to equivalent groups. Comparisons, therefore, should be made with reference to order of practice, or with reference to composite data in which all orders are averaged.

Table 1 suggests that a marked difference exists in the difficulty of the three series; the difference between the named and the unnamed series is interpreted by the writer as due to the factor of verbalization. The difference between the named series and the animal series may also be due in part to this factor, since the animals bear names which are already familiar, while the names of the nonsense objects are learned during the experiment, and are applied with relatively less readiness and certainty.

It remains only to be demonstrated that the differences are not a function of ability differences in the groups, nor of extraneous factors in the procedure. This is shown by tables 2 and 3, which give the same order of differences as table 1. The averaged

TABLE 1

Comparisons of scores on the series presented first

GROUPS	SERIES PRESENTED FIRST	NUMBER OF CASES	MEAN[1] NUMBER OF TRIALS	MEDIAN NUMBER OF TRIALS	S. D. NUMBER OF TRIALS	RANGE NUMBER OF TRIALS	PERCENTAGE OF COMPLETE FAILURES	PERCENTAGE SUCCEEDING IN 25 OR LESS TRIALS
5 and 6	A. Unnamed	28	47.1 ±3.6	69	22.5	8–91	36	14
3 and 4	B. Named	25	28.3 ±3.3	37	22.1	2–76	20	44
1 and 2	C. Animal	27	6.6 ±.6	5	4.7	1–15	4	95

[1] Omitting cases of complete failure.

TABLE 2

Comparison of scores on the series presented second

GROUPS	SERIES PRESENTED SECOND	MEAN[1] NUMBER OF TRIALS	MEDIAN NUMBER OF TRIALS	S. D. NUMBER OF TRIALS	RANGE NUMBER OF TRIALS	PERCENTAGE OF COMPLETE FAILURES	PERCENTAGE SUCCEEDING IN 25 OR LESS TRIALS
2 and 4	A. Unnamed	12.4 ±1.9	6	12.97	1–53	0*	75
1 and 6	B. Named	9.1 ±1.4	6	8.99	1–34	9	82
3 and 5	C. Animal	5.4 ± .8	4	5.7	1–25	4	96

[1] Omitting cases of complete failure.

* Children completely failing the named series were not given the unnamed series.

data for all groups and all sequences are presented in table 4.

The "correct" object in the unnamed series was spontaneously named or described by thirteen of the children. The average learning score for these children on this series (11.9) is significantly lower than the average learning score of 47.1 for all groups on this series. The scores of the children the descriptions are "flat on top," "remember the point that's on it," "the smoothed one," and "like Mount Hamilton." All the children who verbalized the "correct" object in the unnamed series solved the problem.

Several interesting remarks were made by the children about the relative difficulty of the three series. A six year old girl in group I, whose

TABLE 3

Comparison of scores on the series presented third

GROUPS	SERIES PRESENTED THIRD	MEAN[1] NUMBER OF TRIALS	MEDIAN NUMBER OF TRIALS	S. D. NUMBER OF TRIALS	RANGE NUMBER OF TRIALS	PERCENTAGE OF COMPLETE FAILURES	PERCENTAGE SUCCEEDING IN 25 OR LESS TRIALS
1 and 3	A. Unnamed	8.9 ±1.8	3	12.5	1–51	4	83
2 and 5	B. Named	5.6 ±.9	3	6.4	1–27	0	95
4 and 6	C. Animal	2.9 ±.4	2	2.1	1–8	0	100

[1] Omitting cases of complete failure.

TABLE 4

Comparison of scores made on the three series regardless of the order of presentation

GROUPS	SERIES	MEAN[1] NUMBER OF TRIALS	MEDIAN NUMBER OF TRIALS	S. D. NUMBER OF TRIALS	RANGE NUMBER OF TRIALS	PERCENTAGE OF COMPLETE FAILURES	PERCENTAGE SUCCEEDING IN 25 OR LESS TRIALS
1 to 6	A. Unnamed	21.3 ±1.95	16.5	22.6	1–91	15	54
1 to 6	B. Named	14.2 ±1.6	7.5	18.1	1–76	10	72
1 to 6	C. Animal	5.3 ±.4	4	4.8	1–25	3	97

[1] Omitting cases of complete failure.

spontaneously verbalizing the "correct" object (unnamed series) were considered in computing the averages; thus there is probably a greater difference in difficulty between the unnamed and the other two series than is indicated by the comparison of average scores. Examples of the names given the "correct" shape are "the cup," "Old Mother Shoe," "the slide," and "the piece of cake;" and examples of scores on the animal, named and unnamed series were respectively 4, 4, and 6, remarked when solving the unnamed series, "I wish we had the animal game; I can remember the animals." A boy aged five and a half, who was given the unnamed series after the named, said on the unnamed series, "If they had names, that would be fine."

Of the children who solved the

named series, 90 per cent gave the name of the "correct" object when the experimenter asked where the toy had been found. The scores of the children who did not respond with the name were scattered equally above the below the median scores of their respective groups. Twelve per cent of the children said the name of the "correct" stimulus object as they looked at the objects before picking one up (e.g., "Where's Mobie?" "Mobie's going to have it.)". Sixty-four per cent of the children named the "correct" object of their own accord as they picked it up. Thus practically all the children knew the name of the shape having the toy and many of the children actually used this name when solving the problem. It is possible that even if the child did not recall the name of the "correct" object on seeing it, a stimulus object would be recognized more readily as the "correct" one as a result of the differential auditory and proprioceptive stimuli previously received in the naming of that object.

In a comparison of the performance of the boys and the girls, it was found that 55 per cent of the boys' scores fell below the median learning scores. On the other hand, twelve of the girls failed completely to solve one of the three learning problems, as compared with six of the boys. No consistent nor reliable sex difference is indicated.

The relation of chronological and mental age to the learning scores obtained on the three series is indicated by the following rank-difference coefficients of correlation:

NUMBER OF CASES	SERIES (FIRST PRESENTATION)	C. A.	M. A.
28	A. Unnamed	−.39	−.35
25	B. Named	−.72	−.62
27	C. Animal	−.19	−.21

With the effect of chronological age eliminated, the correlation with mental age would be negligible. The relatively low coefficients obtained in the case of the unnamed and animal series, are apparently due in part to their limitations in range of difficulty, the animal series giving a piling-up of good scores, the unnamed series an accumulation of zero scores.

SUMMARY AND CONCLUSIONS

1. Comparisons were made of the learning scores of 80 children between the ages and two and seven years on three series of problems of the multiple choice type. The stimulus objects used for the three series included animal shapes, unnamed 3-dimensional "nonsense" forms, and a similar series of forms with nonsense names.

2. The scores on each series (in terms of number of trials required for learning), exhibited marked individual differences. Correlations with C. A. ranged from −.19 to −.72; with M. A., from −.21 to −.62.

3. A transfer effect was demonstrated from one series to another, as shown by improvement in the performance on successive series.

4. When the three modes of procedure were compared, eliminating practice effect by rotation in matched groups, the median number of trials on the animal series was found to be 4,

on the named series 7.5, and on the unnamed series 16.5 (table 4).

5. Data on complete failures and on the percentage succeeding in a given number of trials, are in support of the conclusion to be derived from (4), namely, that verbalization served as a distinct aid in learning.

6. Through the superiority in the learning of the animal series, the results further indicate the influence of interest factors in learning.

A Genetic Study of Laughter Provoking Stimuli[1]

Florence Justin

LAUGHTER and its causes have been favorite subjects for theorizing for two thousand years. Attempts to explain the phenomenon of laughter probably extended even further back into man's history, but these are unrecorded or unavailable. In the extensive literature that has accumulated, the theories of laughter have in most cases been set forth at great length. With all the writing, the important problems are still controversial and there has been evolved no one principle that has won general acceptance as an adequate explanation for laughter.

One of the first of the theoretical problems to emerge is whether laughter is innate or acquired. In endeavoring to answer this question, Sully (32) calls attention to the age at which it is manifested and mentions the fact that Laura Bridgeman, who was blind and deaf and could not possibly have learned the response, laughed. Goodenough (12) reports that a deaf, dumb, and blind girl studied by the Institute of Child Welfare, laughs. This is more conclusive, for Laura Bridgeman did not lose sight and hearing until two years, but this child has been blind and deaf from birth. That laughter is innate seems to be the generally held opinion of the psychologists of today. Gates (10) would link it with mastery as a strong native impulse. Greig (14) would associate it with the love instinct. Stern (31, p. 126) says, "All these early movements of expression have an instinctive character, there is in them . . . . in distinction from those that follow later, nothing conventional or acquired." Allport (1, p. 253) says that while the act of laughing is inborn, "the range of things that can be laughed at is extended by experience." Woodworth (35, p. 158) states, "One thing is fairly certain: that, while laughing is a native response, we learn what to laugh at for the most part, just as we learn what to fear." This seems to be the generally accepted psychological view.

In the biographical studies of children, considerable material regarding the appearance of the first smile and laugh is to be found. This material is summarized by Sully (32), Greig (14) and by Eastman (7). After comparing dates recorded by Darwin, Preyer, Champneys, Sigismund, Moore, and Shinn, Sully concludes that (32, p. 166) "We find, within the first two or three months both the smile

[1] From the Institute of Child Welfare, The University of Minnesota. Condensed for periodical publication by Mary Shirley.

and the laugh as expressions of pleasure, including sensations of bodily comfort and gladdening sense presentations. We find further, in the reflex reaction of laughter under tickling, which is observable about the end of the second month, the germ of fun, or of mirthful play." More recent observations as by Fenton (9) and Stern (31), and the experimental work of Jones (18) confirm the conclusions of Sully regarding the early development of the smile and laugh.

The further development of laughter during the first three years of life is traced by Sully. Aware that "the new child psychology has not yet produced a methodical record of the changes which this interesting expression of feeling undergoes," (32, p. 186) he turned to the data available. He compiled material from the various biographical studies, compared these with his observations of his own children, and came to the conclusion that "within the first three years all of the main directions of mirth of adults are foreshadowed. Humor itself, which is supposed to come with a maturity of feeling and reflection, begins to announce itself in a modest way during this period." (32, p. 218.)

Watson (34, p. 104) states of smiling, "it begins at birth—aroused by intraorganic stimulation and contact. Quickly it becomes conditioned; the sight of the mother calls it out, then vocal stimuli, finally pictures, then words and then life situations either viewed, told, or read about. Naturally what we laugh at, and with whom we laugh are determined by our whole life history of special conditionings. No theory is required to explain it, only a systematic observation of genetic facts." If such a systematic observation of facts has been made by Watson, a more adequate presentation of data is to be desired. That the smile manifests itself at birth is not upheld either by biographical studies or by experimental work on the early behavior patterns of children. Jones states that the early reflex smile "may be seen as early as the first week. Moore reports a smile on the sixth and seventh day." (18, p. 541.)

Washburn's study deals with the development of the smile and laugh in the infant (33). She observed fifteen children at four week intervals during the first year of life, in a controlled situation where stimulation of laughter and smiling was possible. Laughter occurred later chronologically than smiling, but the author considers it the more primitive form of expressive behavior; smiling, as the child nears the age of one, being much more a learned or conditioned response.

Closely connected with the problem of the instinctive nature of laughter is the question of its universality of manifestation. This is discussed by Sully (32, Chapter 8), authorities being cited to establish it as a characteristic of humans everywhere. Do animals laugh? is another phase of the problem which has come in for considerable discussion. Sully concludes from the observation of Darwin and Robinson, that "the young of the higher apes have something resembling our smile and laugh and produce the requisite movements when pleased. . . . . It further occurs when the animal is tickled." (32, p.

163.) Kohler (22, p. 319) says, "I have never seen anthropoids weep nor laugh in quite the human sense of the term. There is a certain resemblance to our laughter in their rhythmatic gasping and grunting when they are tickled and probably this manifestation is, physiologically remotely akin to laughter. And during the leisurely contemplation of any object which gives particular pleasure (for example, little human children), the whole face, and especially the outer corners of the mouth, are formed into an expression that resembles our 'smile'."

That the expressive movements—of which laughter is one—seem to differ from the other instincts "in that they do not stand in any direct relation to definite consequences," is Koffka's conclusion. (21, p. 115.) According to Allport (1, p. 252) "The greatest obstacle to a satisfactory explanation has been that, unlike other basic forms of behavior, laughter does not serve any known biological purpose." Biological benefits resulting from laughter have certainly been claimed. Sully summarizes the early medical views favoring laughter as an exercise. (32, p. 33.) Darwin says, "Joy quickens the circulation and stimulates the brain which again reacts on the whole body." (6, p. 80.) That laughter hastens the digestive processes has been commonly held. Reports on the inhibiting effects of anxiety, rage or distress are more frequent in the literature than are articles dealing with the stimulating effect of laughter. Alvarez concludes that "much experimental evidence has been gathered to show that emotions can stimulate or inhibit not only peristalsis, but also the flow of the salivary, pancreatic and gastric juices." (2) As yet we do not find psychologists recognizing these physiological benefits as the biological purpose of laughter essential to its explanation.

Eastman considers laughter far from purposeless; there is in play—manifested by laughter—the germ of the sense of humor which is of tremendous value to man. "It is a very inward indispensable little shock absorber—an instinct, as we might call it, for making the best of a bad thing." (17, p. 21.) McDougall advances the defensive aspect of laughter in a slightly different way. To him laughter has been evolved in the human race as an antidote to sympathy or as a protective reaction, shielding us from the depressive influence of the shortcomings of our fellowmen (27).

That laughter has not a biological but a social function is the suggestion set forth by Hayworth. (16, p. 368.) This concept will bring, he believes, "a certain amount of order out of the psychological and philosophical chaos now surrounding the discussion of laughter." "My theory of laughter is that laughter was originally a vocal signal to other members of the group that they might relax with safety." Its use was then volitionally extended to other forms of communications to the group. Darwin, too, recognized the expressive movements as means of communication and held that they are, as such, of importance in our welfare (6, p. 385). That as a means of communication the smile and laugh have a social function is generally acknowledged. Though these explanations do provide a purpose for

laughter they have not been universally accepted as removing the obstacle indicated by Allport.

The most difficult question about laughter, according to Woodworth 35, p. 57) is to tell in general psychological terms what is the stimulus that arouses. To explain the cause of laughter in any terms whatever is evidently a very difficult task—but its difficulty has not deterred many people from attempting it. Through the observation and analysis of laughter-provoking situations, stories and characters, the problem has been approached. The laughable has been differentiated into the ridiculous, the ludicrous, the comic, the witty, the humorous. Certain characteristics of the laughable have been selected and by speculation and analysis theories of laughter evolved from these to explain the cause of laughter.

In 1897, Hall insisted that we must go back of speculation to rebase our theories of laughter causation on wide empirical data. "We are persuaded that all current theories are utterly inadequate and speculative, and that there are few more promising fields of psychological research." (15, p. 40.) The attempts to enter these promising fields are as limited as the theoretical discourses are extensive. Experimental findings relating to the causes of laughter will be briefly reviewed and later the methods employed in these studies will be discussed.

Robinson (28) classified various parts of the body as to ticklishness and emphasized the part played by the social element in the smiling response of young infants. In Hall's findings, information is set forth regarding ticklish areas on the body, and the things children find amusing. The irradiation of sex into many social activities is noted and the relaxing of constraint given as a cause of laughter. Quoting Hall, "This reversionary cause of laughter, which has not hitherto been recognized, we deem one of our most important contributions to the subject." (15) Miss Martin's results indicate that several theories are involved in the comic. Thirty-seven of the 60 subjects reported a feeling of superiority in connection with the picture stimulus, and all but seven reported responses which could be classed under contrast, contradiction or incongruity. The author concludes therefore that contrast is an essential element in the comic (26). The findings of Hollingsworth's study uphold Schauer's theory of the comic. Schauer divides the comic into the objective comic, where the trick is perpetrated on others by natural forces, a third person, or by the victim's own blunder and the subjective comic where we are the object of the trick and feel duped (17). The conclusions of the Scofield study (29) are that no single theory can account for all laughter; that a feeling of superiority tends to be the most fundamental cause of most laughter. Kambouropoulou (19) concludes that the types of humour consistently shown are primarily the personal and the impersonal—though mention is made of laughter at physiological and physical causes. The personal type involves the superiority of the subject, and the impersonal type arises from the perception of incongruity, either of situations or ideas. Mental ability, as

represented by academic standing decreases the proportion of physiological laughter and of laughter at a physical cause, but bears no relation to the personal and impersonal types of humour except by increasing the appreciation of the nonsense jokes. Barry, Jr. (3) reports that incongruity and suddenness play an incidental part in humour; that the situations provoking humour are those which are emotionally weighted for the subject and that it is possible that humour is *due to the change from an unpleasant* to a neutral or pleasant state. Age variations in laughter-provoking elements and sex differences in laughter response are indicated in the studies of Kimmins (20) and Wynn-Jones (36), but specific information is not given in the brief reports. Enders' study (8) emphasizes the part played by the social element in the laughter of children, and furnishes information regarding the frequency and length of their laughter in nursery school. Jones (quoted by 34, p. 141) lists the situations in nursery school in which smiling and laughing occur and notes that the same stimuli can at one time call forth laughter and at another crying, depending upon the intra-organic condition of the youngster. In Landis's study of emotional reactions, smiling or laughter was a response to 34 per cent of the experimental situations. He explains this in the nature of relief at the tension set up by the situations (24).

Since the early attempt of Robinson to test the degree of laughter responsiveness to tickling, the methods used in the studies reported have been various. Hall collected much data by use of the questionnaire (15). Martin, with comic pictures for stimuli, used undirected introspection, six psychological experimental methods and a questionaire for directed introspection (26). Hollingsworth's experimental set-up consisted of a series of comic jokes (17). Scofield used a standardized scale of jokes and comic pictures in her experiments (29). Kambouropoulou had her subjects keep humour diaries for a week (19). Barry Jr. employed association time reactions *in his study* (3). *Kimmins* used funny stories and jokes (20), and Wynn-Jones two series of various forms of wit (36). Enders presented toys to children in an experimental situation (8); the observation of children in nurseryschool was done by both Enders and Jones. Landis's experimental material included pictures, jokes and situations (such as putting the hand into a bucket of frogs and cutting off a rat's head) (23). Washburn (33) by means of peek-a-boo with a cloth, reappearance of the experimenter from under the table and from behind a closed door, rhythmical hand-clapping and knee-dropping, elevator-play, threatening head of child, informal situations and social attempts, endeavored to elicit smiles or laughter in infants.

To enumerate all the various theories of laughter is not our purpose, but a classification setting forth the main types of explanation will be attempted. The first possible classification would be to distinguish between those theories admitting one or more elements to be active in producing laughter and those which, rejecting multiple causation, would explain all laughter by

one formula. This does not, however, prove practicable—few theorisers state as specifically as did Schaupenhauer that "the cause of laughter in every case is —." Often even if a positive statement regarding a single cause of laughter is made some qualification is added which really permits of multiple causation. For instance, Thomas Hobbes' well-known pronouncement that laughter "is the outward sign of a passion which is nothing else but sudden glory arising from a sudden conception of some eminency in ourselves by comparison with the infirmity of others or with our own formerly," would add surprise to the feeling of superiority as a cause of laughter.

The theories of laughter of the many philosophers, poets, and psychologists listed by Greig (14) were classified as carefully as possible. This was a difficult task, since the writers were often obscure and hard to understand and since they discussed different forms of the laughable and used words with little uniformity in meaning. The theories of these writers were compared with those propounded by Sully (32), Hall (15), Sidis (30), Eastman (7), and Gregory (13). From this analysis and comparison emerged the following main theories of laughter causation.

THE THEORY OF SURPRISE AND DEFEATED EXPECTATION

Included here are those explanations which mention surprise—a sudden presentation for which the mind is not perfectly pre-adjusted at the moment —or defeated expectation—a dissolution of a definite anticipation of some particular concrete sequel to what is presented to the mind at the moment, as involved in the production of laughter. Although playing a part in many theories, (30 per cent mention it) few attempt to explain laughter altogether by defeated expectation or surprise.

DEGRADATION-SUPERIORITY THEORY

Under this heading are placed the variations of the 'sudden glory' theory that laughter is due "to some sense of superiority in the laugher," or that laughter gives voice to "man's tendency to rejoice over what is mean and degraded." Thirty-eight per cent of the writers advance this explanation.

THEORY OF INCONGRUITY AND CONTRAST

This division includes those theories which mention as the cause of laughter, presentation of what is at variance with the normal custom or rule, with desirability, sense or reason. This explanation was offered by 42 per cent of the theorists.

FREEDOM OR RELIEF FROM STRAIN THEORY

Explanations of laughter involving a sense of freedom or release from repression or external constraint, from monotony or from logic or reason, advanced by 10 per cent of the writers, are placed here.

JOY, PLEASURE AND PLAY THEORIES

Entered here are those which hold that laughter arises from a sudden accession of happy consciousness, and that the point of view from which things appear laughable is the point of view of play. (Suggested by 23 per cent of the authorities.)

THEORIES RELATING TO THE SOCIAL ASPECT AND FUNCTION OF LAUGHTER

These included those mentioning the smile or laugh as a means of signifying feeling to others; the effect of social relationships upon the manner the laughter is received; the relationship to time and custom, and the aim of laughter. That laughter is "consciously or unconsciously corrective in aim" is held by one group whose modern representative is Bergson. Representative of the other group Dugas maintains that laughter is a-social and a-moral in itself. Thirty per cent of the theories of laughter listed by Greig dealt with this phase of the subject rather than with the cause of laughter.

DEFENSE THEORY

These opinions, of six per cent of the writers, find in laughter "a simple emotional mitigation of failure; "a means to prevent real human loss and make for harmony," or "to protect us from the shortcomings of our fellowmen."

THEORY OF SUBCONSCIOUS GRATIFICATION

Explanations of laughter as the result of suddenly released repression and the physical sign of subconscious satisfaction were advanced by two per cent of the theorists.

PHYSIOLOGICAL OR ENERGISTIC THEORIES

Classified here are those theories that seek to explain the causation of laughter through physiological phenomenon or cerebral mechanics. Eleven per cent offered this explanation. According to Eastman, the classic and supreme expression of this is in Herbert Spencer's essay on "The Physiology of Laughter." (7)

MISCELLANEOUS GROUP

Into this went all the incidental ideas that would not fit into the other classes.

In the above classification incongruity or contrast was the explanation for laughter most often advanced; the superiority-degradation theory was mentioned next often; surprise or defeated expectation as an element of the comic, and the social aspects of laughter received equal attention from the writers in their explanations of the laughable. Other theories were cited less often. On the basis of opinions set forth in the theoretical literature. it is evident that laughter must be explained in terms of multiple causation.

PURPOSE AND METHOD

The purpose of this study was to devise test situations exemplifying the different theories of laughter causation, and to determine the responsiveness of young children to these various types of laughter-provoking stimuli.

Subjects

As subjects 96 children, 12 boys and 12 girls at each yearly age level from 3 through 6 years, were used. The age intervals had a range of an entire year; that is, the 24 children between 3 years 0 days and 3 years 364 days were regarded as 3-year-olds. The children of each sub-group were chosen from homes representing a cross

section of the Minneapolis population in socio-economic status. To be specific the 12 children of each sex at each age were distributed thus: 1 from Occupational Group I, 1 from Group II, 4 from Group III, 3 from Group IV, 2 from Group V, and 1 from Group VI. The preschool children were obtained from nursery schools, day nurseries, and kindergartens about the city, and the 6-year-olds came from the first grade of the public schools.

Intelligence quotients were obtained from 95 of the 96 children. The Minnesota Preschool Test was used on the preschool children and either

TABLE 1

Chronological age, mean I.Q., and range of I.Q. for age groups

MEAN CHRONOLOGICAL AGE	I.Q. MEAN	I.Q. S.D.	I.Q. RANGE
3 years 5.45 months	106.83	10.50	77–122
4 years 4.97 months	108.29	11.64	85–130
5 years 5.23 months	111.21	9.34	97–128
6 years 5.65 months	103.70	12.03	76–125

the Stanford or the Kuhlmann revision of the Binet scale on the 6-year-olds. Table 1 gives the means for each age group.

Laughter-provoking situations

Not all the theories were adaptable to experimentation with young children. The theory of subconscious gratification and the defense theory would be difficult to attack experimentally, and the social aim of laughter seemed outside the scope of this study. Consequently, the attempt was made to deal experimentally only with the theories of surprise and defeated expectation; of superiority-degradation; of incongruity or contrast; of play; of relief from strain; and with the social smile as a stimulus.

The devising of situations to set forth these theories was no small task. Even to surprise the child without awakening too great fear requires care in the planning of situations. It is difficult indeed to present incongruous situations to a child whose standards of what is congruous are not well defined. Similarly, one is at a loss to know just what is regarded as degrading, by the child. The devising of superiority and degradation situations presents another problem. As Sully has pointed out (32, p. 136) many if not all amusing losses of dignity logically involve contrariety between what is presented and the normal custom or rule, and again incongruities which are lapses from standard ideas may certainly be regarded as degradations. To get freedom, or relief from strain the child must first be subjected to strain, and yet at the same time, the situation must not be such as would cause him to rebel, or resort to tears or anger. To devise a situation which would present social stimulation without involving other elements was a perplexing problem.

It was originally planned that the theories should be presented in actual situations, in pictures, and in stories. Owing to the length of time required, the stories were omitted, but where the theory permitted, pictures as well as actual situations were used. Situations which might be described as essentially verbal in character were, however, employed. Suggestions were obtained from many sources. Some of the situations are taken from

the literature, and are rather trite illustrations of the theories involved. Such were the man's hat and the baby's bonnet situation used in the incongruity and contrast section; Jack-in-the-box, peek-a-boo, and tickling in the surprise section; and the masks, sitting on the floor, and putting the watch instead of the egg into water, in the superiority and degradation section. The situations used were selected from a considerably larger number. However, just as the devil, in Kipling's poem kept whispering in the artist's ear, "It's pretty, but is it Art?" so it might be asked of each classic example as of the other stimuli, "It's interesting, but does it really involve surprise or incongruity?" To this, one can only reply that, to the best of our knowledge no situations which more truly involve surprise or incongruity for children can, at present, be cited.

By a preliminary experiment, those items which were difficult to control were omitted, and the experimental method of presentation was standardized. This standardized material is set forth in the following:

A. Surprise or defeated expectation situations

A 1 a, A 1 b, A 1 c. The experimental material consisted of three little buckets, a red one containing sand, a blue one containing water (about an inch and a half in each case), and a purple one, which was empty. Each was covered with a paper of the same color, slit and slipped through the bail. These were placed before the subject with the remark, "——, I have here three little buckets, one is red, one is blue, and one is purple. First, you may put your hand in the red bucket—like this—and tell me what is in it." (If necessary, 'Without looking, feel first and then you may look afterwards if you want to'.) "Now put your hand in the blue bucket and tell me what is in it." (Urge as above if necessary) "There was sand in the red bucket, and water in the blue bucket. Now we will find what is in the purple bucket. Put your hand in and tell me."

A 2 a, A 2 b. The material here was a white crepe paper handkerchief. The child was asked, (using child's name), "Did you ever play the game of Where's ——? We play it like this, (throwing handkerchief over child's head) Where's ——? Why here she is!" (5 seconds for response) Repeat. (5 seconds for response)

A 3 a, 3 b, 3 c, 3 d. For this situation there were four wooden boxes, five inch cubes, with hinged lids, closed in front with a hook to which was attached a red cord. Three of these contained Jack-in-the-box springs, A3a, with a small doll with a full skirt, A3b with a red rose, A3c with the usual grotesque Jack. The fourth box, A3d, was empty. The boxes all opened fairly vigorously when the red cord was pulled. In A3d, the empty box, a band of elastic fastened to the inner lid and to the back of the box caused it to open when the red cord was pulled. These boxes were placed on the table in front of the child with the remark, "Here are four boxes all the same size, all the same color, and all in a row. They all have little red strings fastened to them. We are going to open them and find out what is in them. First we will open this one and see what is in it. I'll hold the box and you pull the string. What is it?" (Difficulty was encountered in keeping the child from holding the lid of the box down with the one hand while he pulled the string with the other. Frequently, repetitions of, "I'll hold the box, and you pull the string," were necessary.)

The first box was placed back and the next one brought forward with, "Now let's see what is in this box. What is it?" For the fourth box the experimenter said, "There was a doll in the first box, a rose in the second box, and a little old man in the third box. Let's see what is in this." After time for response to this had been given the

child was asked, "Which one did you like best? Point to it."

A 4 a. A yellow and purple ostrich feather obtainable in the ten cent store as a pen holder was shown to the child with the remark, "I have here a pretty feather. It is a yellow and purple feather. It is called a tickle feather, and is used to tickle boys and girls under the chin. Do you like to be tickled?" (moving feather in four continuous strokes back and forth under the child's chin).

In one of the preliminary experiments the child who was playing with the feather while the experimenter recorded, said spontaneously, "I can tickle myself," and did so. As this is a disputed point in material on tickling, thereafter at the close of the tickling by the experimenter the child was given the feather with the remark, "You might see if you can tickle yourself. Can you?"

B. Superiority and Degradation

B 1 a, 1 b. The material for this situation consisted of a little electric stove, on which was a small aluminum pan two-thirds full of water, an old fashioned heavy gold watch, and an egg. Asking the child to come to the table the experimenter said, "—— I have here an egg, and I think I am going to cook it this morning. The egg should go into the water to be cooked, and the watch will show us when the egg has been in the water long enough. Usually, we cook an egg three minutes to have it as most people like it for breakfast. Now I'll hold the watch in my hand, and put the egg on to cook." At this point the experimenter dropped the watch in the water and stood looking at the egg. If there was no response in five seconds, the experimenter exclaimed, "Oh, My! I put the watch instead of the egg into the water! How foolish! We'll have to take the watch out of the water and hope it did not get spoiled."

B 2 a-b-c-d-e-f. Three masks were presented here, a clown face, a red face with protruding ears, and a sheep's face. The child was gotten back to his seat by being told, "Now you may sit down, and I'll show you my masks." As the masks were placed before the child the experimenter continued, "This one (B 2 a) is that of a clown in a circus. This one (B 2 b) is of a red faced man whose ears stick out, and this (B 2 c) is that of a sheep. Would you like to try them on? I'll hold the mirror and you may see which one you like best. (Assistance in trying on the first mask selected was given if necessary) When the masks were first seen, a reaction time of five seconds for each was allowed. In trying on the masks, the response of the child up to 45 seconds was recorded. The trying on of the masks counted as situations B 2 d, B 2 e, and B 2 f, in the order given.

B 3 a, b. "Now I'll put the masks away, and we'll sit down and look at some pictures. There is a chair for you, and here is one for me." Saying this the experimenter missed the chair and sat on the floor. (Five seconds for response) Then the experimenter exclaimed, "Oh Dear! I fell down. These little chairs are hard for big people to sit on." (Response taken for B 3 b)

B 4 a-b-c-d-e-f-g-h. Sitting down on the little chair the experimenter placed the pictures in front of the subject one at a time. The pictures were simple pen and ink drawings made at the Medical Art Shop of the University. The first picture was a copy of one in Edward Lear's Nonsense Book. (25) The others were drawn to set forth situations which are described by the following explanations given to the children with the presentation of the pictures.

B 4 a. "This man has such a long nose that all the people are laughing at him."

B 4 b. "This little boy is giving that little boy a kick in the seat of his pants. Which little boy would you rather be?"

B 4 c. "This little boy is falling down stairs, and he is afraid he will get hurt."

B 4 d. "This man is chasing his hat which the wind is blowing away. Perhaps he will catch it."

B 4 e. "This little baby is crying. I don't know why, but he is crying."

B 4 f. "This boy is crying because he cut his finger."

B 4 g. "This boy is getting a spanking.

His mother is spanking him and he is crying."

B 4 h. "This little boy is getting ready for a bath. He is all undressed and ready for a bath."

B 5 a, 5 b. Holding a street car token between the forefinger and thumb of the left hand the experimenter said, "I have here a token like you give the man to ride on the street car. I am going to take hold of it like this" (apparently taking it with the fingers and thumb of the right hand; the token is instead dropped back into the left hand). Then both fists were presented to the child with the question "Where is it?" The hand the child selected was opened. If he selected the empty hand he was told, "Guess again Where is it?" (B 5 b).

B 6 a, B 6 b. A common mirror was held up before the child with the comment, "You have seen yourself in a mirror, haven't you? Most children have." (B 6 a) Putting the mirror away, a distortion mirror 18 x 28 inches long, supported on an adjustable stand, was turned around and adjusted in height so that the top of the child's head was five inches below the upper edge of the mirror. This was presented with, "Now I'd like to have you see yourself in this mirror. We got it especially for children. Let's see how you look in it." The response during the first minute of exposure only was noted. The child was then asked, "Which mirror do you like best?"

B 7 a-b-c. As the child took his seat the experimenter said, "You know, ——, the other day on the street I saw a man who walked like this, (dragging one foot and limping) (B 7 a) and all the time he kept making a face like this (winking one eye and drawing up the side of the face) (B 7 b) and when he stopped to ask me the time he said, 'S-S-Say. Whwh-what t-t-time is it?' (B 7 c) Just like that. Did you ever see any one do like that?"

C. Incongruity and contrast situations

C 1 a. A doll in the back of whose head eyes had been inserted was shown, attention being called to her normal features before the incongruously placed eyes were revealed. "I want you to see my doll. She is such a nice doll. She has teeth. She can go to sleep. She has real hair with a ribbon on it, and just look! She has eyes in the back of her head." (reaction time) "Isn't that fine?" or, "Isn't she a nice dolly?"

C 2 a. A small wooden doll chair, with legs three fourths of an inch square, on each of which was fastened a doll's shoe, was next presented. The chair was partially wrapped in paper as it was placed before the child. The experimenter said "I'd like to have you see my doll's chair. We like it very much. It has a back and it has arms. It has legs, and (removing the paper) it even has shoes on its legs, (reaction time) "Isn't that a nice chair for dolly?"

C 3 a. Bringing out a man's silk hat and a baby's bonnet, the experimenter said, "I have here a man's hat and a baby's bonnet. I shall put the baby bonnet on my head, and tie the strings under my chin like this. Then we will put the man's hat on you like this, and we will look at ourselves in the mirror like this," (holding a mirror on the table before them). Reaction time was counted from the moment when the baby's bonnet was put on the experimenter.

C 4 a. "I want to show you my toy dogs. I have two of them, a big dog and a little dog, and I have a dog house for them." Saying this, the experimenter placed two small celluloid dogs, one larger than the other, with a dog house on the table. "There is a great big door for the big dog to go through (putting the larger dog into the house through the big door) and right beside it a little door for the little dog (putting the smaller dog half way between the two doors. Reaction time. (Is that the way you would make a dog house for them?")

C 5 a-b-c-d. Of the four pen and ink pictures here shown, one was a copy from the Edward Lear Nonsense Book, and the others are described by the forms in which they were presented to the children.

C 5 a. "This man is sitting backwards in his chair with his feet up in the air. Have you ever seen any one sit that way?"

C 5 b. "This man is walking around balancing a teapot on his nose. Is that the way to carry a teapot?"

C 5 c. "This horse is drawing a milk

wagon I think. It is a rainy morning so he is carrying an umbrella so he won't get wet. Did you ever see a horse carrying an umbrella?"

C 5 d. "This cow is playing the piano while that man is milking her. Did you ever see a cow play the piano while she was being milked?"

D. The social smile as a stimulus

Still holding the portfolio of pictures in her lap the experimenter looked up and said, "You know, ———, (smiling five seconds) when I waked up this morning and looked out of the window, it was raining," (or sunshiny, or cloudy, as the case might be) (laughing three seconds), "Just think of that! It was raining!" (laugh and smile five seconds)

E. Relief from strain situations

E 1 a, E 1 b. A chalk line two inches wide and six feet long was drawn on the floor previous to the experiment. The child was told, "The next game we will play will be walking this line. You can walk a line without falling off, can't you? Well, in this game you are to carry this little parasol over you with one hand, and you are to carry this potato on the spoon in front of you with the other hand." The experimenter stood at the other end of the line and said, (E 1 a) "All ready? Go!", and kept urging, "Keep on the line. Hold the parasol over you, Keep the potato on the spoon in front of you." (E 1 b, response on finishing)

F. Play situations

F 1 a-b-c-d. Verbal play. The first verse used had been very mirth provoking in the nursery school with groups of children, the previous year. The experimenter said, "Sit down here and I'll read a verse to you. It is called 'Picnic', and is about a mother who took some children out for a picnic and when it came time for lunch she told each one what to do to get the meal ready."

F 1 a. "Ella, fella
Maple tree.
Hilda, builda
Fire for me.

Teresa, squeeza
Lemon so.
Amanda, handa
Plate to Flo.

Nora, pour a
Cup of tea.
Fancy, Nancy!
What a spree!"

Smiling at any time during this presentation, as well as that beginning within ten seconds after it was counted. The same holds true for the three other verbal play situations.

F 1 b. "Ella Fella" was repeated as fast as possible.

F 1 c. The child's own name was substituted in the following verse, said slowly:

"Robert-bom-barbert,
Tee elegant targert,
Tee legged, toe legged,
Bow legged Robert."

F 1 d. "Robert" repeated rapidly.

F 2 a. The Jumping-Jack used here was a Dutch doll of not particularly grotesque appearance. The toy was hung on something and the child told, "Here is a Jumping-Jack. If you pull the string it will dance for you." If necessary a demonstration was given in making the doll dance. Response was observed for 25 seconds from the time the child took the string.

F 3 a. The flicker top was a ten cent store toy, with a central knob, which when spun caused a circular movement of an inner vari-colored disk. This was placed before the child and spun, the experimenter saying, "If you spin this, it makes the colors come and go." The top was stopped and the child told, "You may do it." The child's response was observed for 45 seconds from the time he took the top.

F 4 a. For the tower building situation, a nest of six blocks, the largest of which was a five inch cube, was used. The experimenter said, "I have here some blocks, and I am going to build a tower like this," (putting one block on another). "Now that it is all finished you may knock it down. That's right, Give it a push." The child was urged if necessary, and in one case the experimenter assisted the child to knock the

tower down. Any response occurring after the child touched the tower was recorded.

F 5 a. An eight tube xylophone was placed before the child with the comment, "This xylophone will make nice sounds if you strike it with this little hammer," (running down the scale). Any response occurring within 45 seconds from the time the child took the hammer in his hand was recorded.

Experimental procedure

Each item of the experimental material was presented separately to the child, who was seated at a low table. When not being presented, the material was kept out of sight. Toys, the response to which was not recorded, were given to the child to busy himself with while the experimenter was recording responses. With the exception of the social stimulation situation, the experimenter throughout endeavored to maintain an interested but unsmiling countenance.

It was found that in practically all instances, responses came within ten seconds of the presentation, if at all. Ten seconds was, therefore, decided upon as the time limit. If no response occurred in the first ten seconds after presentation, the next situation was presented. If response occurred within this interval, exposure was continued until it ceased, and was followed by a five second interval of non-response. In a few instances, the time was reduced to five seconds. These exceptions have been noted. In certain of the play situations, prolonged smiles necessitated limiting the time for which response would be recorded. Such limitations have been noted, as have any other deviations from the general rule.

It is known that the order of presentation does have some effect on the response, though just what the effect is, has not been made clear. In order to prevent the situations representing any one theory from having the advantageous position, the six main divisions were rotated in presentation. A simple rotation whereby the division presented first was transferred to the end of the series for the next presentation, was used. As each age group was divided into four parts containing six children—upper class girls, lower class girls, upper class boys, lower class boys, in these groups, at every age, each of the six main divisions of situations had a first presentation.

RECORDING OF DATA

The record blank contained space for the recording of laughter, of bodily activity, and of speech manifested upon the administration of the various stimuli. The laughter was measured by means of a stop-watch, in seconds of smiles and of laughter. Since the study was concerned primarily with the laughter response, greatest stress was given to the recording of seconds of smiling or laughing. Emphasis was next given to the speech reactions, which were recorded word for word; the bodily movements received scant attention.

Observational error

The accuracy of the experimenter's record of the length of the laughing response was checked by having two other observers keep records simultaneously. Each observed and recorded seconds of response for one child at each age. Pearsonian corre-

lations between these supplementary records and those of the author averaged .95 for one observer and .83 for the other.

Age differences in laughter response

The results were treated in two ways: the mean length of the smiling and laughing response was computed in seconds; and the percentage of children responding with signs of mirth were computed for each situation. Since in a study of laughter a second of laughing is logically of greater value than a second of smiling, the time scores were weighted by giving a second of laughing a value of 2 and a second of smiling a value of 1.

The weighted time scores for the different age groups are given in table 2 and the percentages of response in table 3. In total responsiveness both scores show the same age trend,—an increase in display of humor from three to five years, and a decrease at six years. Time score for the 5-year-olds is significantly higher than for any other age group; the ratio of the difference to its sigma is above 3.0. Differences among the other age groups

TABLE 2

Mean weighted time in seconds of laughter response of 3-, 4-, 5-, and 6-year-old children to total situations and to each of the six main divisions

SITUATION DIVISIONS	3-YEAR	4-YEAR	5-YEAR	6-YEAR
A. Surprise-defeated expectation	4.30	5.70	6.59	5.24
B. Superiority-degradation	2.67	3.72	5.40	3.85
C. Incongruity and contrast	3.91	5.53	9.88	7.41
D. Social smile as a stimulus	4.17	8.08	9.96	5.08
E. Relief from strain	2.67	2.42	3.54	1.73
F. Play	4.97	6.87	8.86	6.52
Total M.	3.53	4.86	6.81	4.97
Total S.D.	2.19	1.66	2.12	2.01

TABLE 3

Percentage laughter response of 3-, 4-, 5-, and 6-year-old children to total situations and to each of the six main divisions

SITUATION DIVISIONS	3-YEAR		4-YEAR		5-YEAR		6-YEAR	
	S. and L.	L.	S. and L.	L.	S. and L.	L.	S. and L.	L.
A. Surprise-defeated expectation	85.83	11.67	93.75	8.33	94.17	23.75	90.41	10.83
B. Superiority-degradation	40.67	9.83	53.17	7.00	69.17	19.33	62.67	10.83
C. Incongruity and contrast	56.25	15.63	72.92	11.46	89.06	33.85	84.38	28.64
D. Social smile as a stimulus	91.67	12.50	95.83	4.17	91.67	20.83	91.67	8.33
E. Relief from strain	47.92	4.17	52.08		54.17	4.17	41.67	2.08
F. Play	56.25	4.17	65.10	5.73	80.73	22.40	72.92	4.69
Total	54.86	10.03	66.13	7.41	78.32	22.22	72.30	12.19

are not statistically significant. The greater responsiveness of the 5-year-olds is also manifested in each of the six categories.

Age differences in the effectiveness of the surprise, the social smile, and the relief from strain categories are small; incongruity, superiority, and play situations become more potent stimuli to laughter as age increases. For the most part the different situations held the same rank in effectiveness at all ages. The social smile was the best stimulus to smiling or laughing, surprise held second place, incongruity third, play fourth, superiority fifth, and relief ranked sixth in eliciting laughter. Although these rankings are interesting and suggestive as to the relative effectiveness of different types of stimuli in provoking children to laughter, they must not be taken too literally, since it is likely that the experimental situations more effectively set forth the theory in some categories than in others; that situations classified under surprise more truly involved surprise than incongruity situations involved incongruity.

Responses to specific situations

Of the ten situations in the division of surprise and defeated expectation, tickling called forth 100 per cent response from 3, 4, and 5-year-olds, and 96 per cent from 6-year-olds. Although it was the most effective stimulus on the whole, the grotesque jack received longer laughs from the 3 and 6-year-olds. In the division called superiority-degradation the mirror situations and the trying on of masks were equally effective at all ages. The funniest picture for the three younger ages was that of the long-nosed man, and for the 6-year-olds was that of the boy being kicked. Under incongruity and contrast the man's hat and the baby's bonnet obtained the most laughs from all ages, although 3-year-olds were equally amused by the doll with eyes in the back of her head, and the 5-year-olds by the dog's house. In the relief situation, the conclusion of the walk with parasol and potato brought more smiles than did the line-walking. In the play situations 3-year-olds gave the highest response to the xylophone, 4-year-olds to the flicker top, and 6-year-olds to the jumping jack. Surprisingly enough, knocking down the tower was more diverting to the 5 and 6-year-olds than to the younger groups.

TABLE 4

Mean response in seconds at the four age levels to actual situations, pictures, and verbal presentations

AGE	SITUATIONS	PICTURES	VERBAL PRESENTATION
3-year	4.73	.91	1.56
4-year	6.41	1.65	2.05
5-year	8.36	3.59	4.22
6-year	6.36	2.64	2.10

TABLE 5

Mean laughter response in seconds at the four age levels to situations in which the child participated, and to those in which he did not

AGE	PARTICIPATING	NON-PARTICIPATING
3-year	5.91	1.35
4-year	7.91	1.89
5-year	9.68	4.06
6-year	7.26	2.86

Relative effectiveness of actual, pictured, and verbal presentation

In tables 4 and 5 the situations are divided respectively on the basis of the manner of presenting stimuli, and on the extent of the child's participation in the situation. At all ages the actual situations provoked longest laughs; verbal "jokes" were next most effective with all except 6-year-olds, and pictures were least heartily laughed at. At all ages the children laughed longer at situations in which they participated, such as trying on masks, mirrors, man's hat and baby's bonnet, than at the situations in which they did not participate, such as the egg and watch, falling off the chair, and looking at pictures.

Relation of laughter response to sex

The mean seconds of response and the percentage response of boys and girls to total situations, and to each of the six main divisions of situations are set forth in table 6.

The mean seconds of total response is greater for the girls than for the boys. In the six main divisions of situations, the girls maintain the lead in mean length of response, except in the superiority-degradation and the relief-from-strain situations. The girls have the greater percentage response with smile or laugh to total situations and to each of the six main divisions; however the boys responded to a greater percentage of situations with actual laughter. Apparently the girls smile more than the boys; the boys laugh more than the girls.

TABLE 6

Laughter response of boys and girls to total situations and to each of the six main divisions. Mean seconds of response and percentage response

SITUATION DIVISIONS	MEAN SECONDS OF RESPONSE		PERCENTAGE RESPONSE, SMILE AND LAUGH AND LAUGH ALONE			
	Girls	Boys	Girls		Boys	
			S. and L.	L.	S. and L.	L.
A. Surprise-defeated expectation	5.50	5.38	94.17	14.37	87.92	12.92
B. Superiority-degradation	3.82	4.01	58.83	10.16	54.00	13.33
C. Incongruity and contrast	7.08	6.30	79.17	21.61	72.14	23.17
D. Social smile as a stimulus	7.33	6.29	97.92	10.43	87.50	12.50
E. Relief from strain	2.44	2.76	50.00	3.13	47.92	2.08
F. Play	7.58	5.95	71.61	9.12	65.89	9.38
Total	5.19	4.89	70.68	12.23	65.12	13.70

Means and sigmas and percentage responses for the sex groups were calculated for each of the 54 individual situations. In each division, the most effective situation for one sex was also most effective for the other. The girls much more than the boys laughed at the exclamation after the watch was dropped into water, and at trying on the clown and sheep masks; the boys much more often than the girls responded to pictures of a boy falling and of a boy getting spanked. The

variability of the boys is greater than that of the girls, their sigmas being the larger in nearly three-fourths of the situations. Aside from variability the comparison of the boys and girls leads to the conclusion that differences in laughter response due to sex are not great.

Relation of laughter response to occupational status

The mean seconds of response, and the percentage of response, of upper and lower occupational groups to total situations and to each of the six main divisions, are set forth in table 7. The greater responsiveness of the children of the upper occupational group is manifested rather consistently.

In the means of the 54 individual situations, the trend of greater response for the upper occupational group is in evidence. It is marked in the smiles and laughter with which the picture of the boy falling downstairs, the picture of a boy with a cut finger, and the picture of a man with a long nose, were viewed by the upper class children. The experimenter's exclamations on dropping the watch in water, and upon sitting on the floor, likewise were greeted more hilariously by them. The wrong guess of the coin they were better able to face with a smile. The semi-serious accidents, whether occurring to themselves or to others are seemingly viewed more lightly by the upper class children. The situation in which the response of the lower group was markedly ahead of the upper was seeing themselves in an ordinary mirror. Their evident greater pleasure in the common mirror is difficult to explain; that mirrors are outstandingly less frequent in the lower class homes seems doubtful.

TABLE 7

Laughter response of upper and lower occupational groups to total situations and to each of the six main divisions. Mean seconds of response and percentage response

SITUATION DIVISIONS	MEAN SECONDS OF RESPONSE		PERCENTAGE RESPONSE, SMILE AND LAUGH AND LAUGH ALONE			
			Upper		Lower	
	Upper	Lower	S. and L.	L.	S. and L.	L.
A. Surprise-defeated expectation	5.67	5.18	93.75	16.04	88.33	11.25
B. Superiority-degradation	4.46	3.37	58.33	14.16	54.50	9.33
C. Incongruity and contrast	7.27	6.12	76.04	25.78	75.26	19.01
D. Social smile as a stimulus	6.94	6.69	91.67	12.50	93.75	10.43
E. Relief from strain	2.91	2.29	51.04	4.17	46.88	1.04
F. Play	7.09	6.45	71.09	11.20	66.41	7.29
Total	5.48	4.60	70.45	11.54	66.05	10.53

Relation of laughter response to intelligence

To determine possible relationship between intelligence and laughter correlations were computed between I.Q. and both length and number of responses at each age. The coeffi-

cients were in general low, but positive. They were higher at the younger ages, those for length of response decreasing from .40 at 3 years to .23, .24, and .12 at 4, 5, and 6 years respectively. The relationship between I.Q. and length of laughing was highest for the division of incongruity.

DISCUSSION

In a truly comprehensive genetic study of laughter-provoking stimuli, the logical point of departure would be the new-born infant. However, the study of the early manifestation of the reflex smile or laugh as an expression of physical comfort and pleasurable consciousness; the study of the emergence of the social smile, and the subsequent differentiation of the response and extension of the stimuli which arouses it, prior to the age of three, has been outside the province of this investigation.

That by the age of three, the child has learned to respond to widely divergent types of stimuli is revealed by these data. All the main divisions of experimental situations, devised to set forth the various theories of laughter, elicited some response from the three year old group. Sully's conclusion that by the age of three, all the adult forms of mirth are foreshadowed in the child would seem to be substantiated by the findings of this study.

When, through the use of the experimental situations, we seek to trace the development of the laughter response in the immediately succeeding years, we are impressed by the marked enlargement in the number of situations which provoke laughter in the four and five year groups. Not only is the field of the laughable being constantly extended, but this takes place, not by a sudden development of one line or increase in the effectiveness of one type of situation, but rather by a gradual extension of response to all the types of stimuli considered. The relative effectiveness of the main divisions of situations does not change markedly or consistently with age.

The enlargement of the field of laughter-provoking objects is seemingly an outcome of the whole process of mental growth. Sully points out that the awakening of the "self feeling" gives rise directly to certain forms of laughter. The consistently greater response to the situations in which the child himself participates, would indicate that "self feeling" may enter into the laughter-provoking effectiveness of the stimuli. To the extent that the child is able to identify himself with others and enter emphatically into situations presented, self-participation should decrease in importance. At all the ages studied, the difference in response to participating and non-participating situations is in favor of the situations in which the child participates. The difference is, however, less marked in the fifth and sixth years than in the third and fourth.

That a certain level of intellectual development must be reached for the appreciation of the more complicated mirthful situation seems probable. Sully says "The first amusement at the sight of the ill-matched, the inconsequent, implies the advance of an analytical reflection up to the point of a dim perception of relations. A large part of the extension of the field

of the laughable, depends upon this intellectual advance, a finer and more precise apprehension of what is presented, in its parts and so as a whole, as also in its relations to other things." The relationship between length of laughter response to the incongruity division and I.Q. is perhaps most clearly indicated in this study, though the correlations of I.Q. and response to the other divisions and total situations were largely positive. A possible trend of decrease of importance of I.Q. with age is suggested by the correlation of mean seconds of laughter response to total situations r being +.40 for the three year olds, +.23 and +.24 for the four and five year olds and +.12 for the six year olds. This may, however, be due to the situations presented. They may be of such a nature that practically all the six year children have the requisite mental level to comprehend them. Perhaps more complicated situations might at this age level show a higher relationship of laughter response with intelligence.

Upon the subject of mental development and the part played by intellectual factors in the production of laughter, the response to the three types of situations presented may throw some light. The verbal presentation of this experiment cannot be said to have involved symbolism; it was largely word play with sound and suddenness as predominating characteristics. The pictures may, however, be regarded as having symbolic meaning. The forward shift, in the sixth year, of the laughter response to the pictorial presentation, might indicate that the load which was previously carried by actual situations is being somewhat shifted to symbolic processes. A large part of the developmental enlargement of what is laughable may depend upon this intellectual advance.

That the development of laughter involves a transition or change in the effectiveness of the objects provoking laughter seem evident. The response of the six year olds to tickling, for example, falls below that of the three year group, while to certain other objects,—empty box, picture of boy getting spanked—it exceeds even that of the five year olds. This latter is rather surprising, for the general trend is a decrease of laughter response in the sixth year. That the experimental situations did not provide for situations which were laughter-provoking for the more advanced mental levels is a possible explanation of this decrease.

It is also possible that the laughter response may undergo a general toning down. The subduing effect of the first grade of the public schools might be suggested as a possible explanation of the drop of responsiveness of the six year olds. The children of this age level all attended the first grade of the public schools and the majority of them were tested in the school buildings, being taken from the classes for the experiment. The younger children were practically all tested in nursery schools and kindergartens where less attempt is made to control the spontaneous laughter. In the first grade the child learns that he is not to laugh at what happens *in school.* Sully says, "A child soon finds out that a good deal of his rollicking

laughter is an offense, and the work of taming the too wild spirits begins." (5, p. 193.) That this occurs with the entry into the first grade seems possible and may account for the decrease in the laughter response of the six year old children studied in this investigation.

Sex differences in laughter response are not statistically significant. That boys laugh more often than the girls, may be due to innate differences or to the social pressure which imposes more "lady-like" standards upon the girls. If the latter is the case, the sex differences should, with continuance of social pressure, increase in size. In the three year group the girls laughed nearly twice as often as the boys, and their laughter response in seconds is greater. The four year old boys in comparison with the girls laughed at a greater number of situations, and their laughter response in seconds is likewise greater. In the fifth year the boys and girls laughed at exactly the same number of situations, but the laughter response in seconds is considerably larger for the boys. The six year old boys laughed more than twice as often as the girls, and the laughter response in seconds is over twice as great. Though not entirely consistent, these results indicate that the laughter response of girls may be repressed into smiling by social pressure.

If smiling is regarded as a means of communication the findings of this study fit in well with those of the McCarty study of language development, which were in favor of the girls (4).

Since the laughter response is positively correlated with I.Q. the differences in intelligence which characterized the sex groups in this study should be mentioned. The mean I.Q. for the girls was 110.4, and for the boys 104.6.

The differences in I.Q. may perhaps enter into the small but consistent occupational differences in laughter response in favor of the upper group. The mean I.Q. of the upper occupational group was 109.4, of the lower group 105.7. The greater responsiveness of the upper group might also be explained on the basis of a more restricted and inhibiting environment of the lower group. Life is for them, perhaps, a more serious affair. The differences show no consistent trend to increase or decrease with age.

In regard to the essential element of a laughter-provoking situation for young children, now as thirty years ago "The one thing that is always present that provokes laughter, to suppress which is to suppress laughter, a variation of which has an immediate effect on the intensity of the emotion of the ludicrous, is still to be found." (3) The responsiveness of children to such a variety of situations, selected to set forth the various theories of laughter, substantiates the statement that the production of laughter is a very complex phenomenon and that any attempt to give it a single cause or explain it by a single formula fails.

The effect of social participation on the laughter response to situations has not been dealt with in this investigation; the effect on response of the progressive building up of the humorous situations has likewise not been determined; findings on these subjects should add to the understanding of the genetic development of laughter.

With the course of development of laughter relatively untouched by previous investigations, the evaluation of the results of this study on 3, 4, 5, and 6 year old children is difficult. The findings can certainly not be regarded as conclusive. Further investigations are needed to determine the transitions that take place at these ages, and at preceding and subsequent ones, and to provide a more adequate and complete picture of the development of laughter. Perhaps when this is available there will likewise be discovered the essential element in a laughter-provoking stimulus, which will serve as a touchstone to solve the intriguing riddle of laughter.

SUMMARY OF FINDINGS

1. In responsiveness of three, four, five, and six year old children to laughter-provoking stimuli, the general trend as revealed by this study, is an increase in responsiveness to the fifth year and a decrease in the sixth. This trend is apparent in total response and in responses to the six main divisions devised to embody the various theories of laughter causation, both in mean seconds and in percentage of response to situations of the four age groups.

2. This change with age is not due to sudden shift in the relative effectiveness of one type of situation in eliciting response. Despite age increase and subsequent decrease, the percentage responses to the main divisions of situations do not markedly change their relative positions. An increase with age in the effectiveness of incongruity to produce lengthy response is indicated.

3. A study of the 54 individual situations leads to the following conclusions: (a) Marked variability in response to laughter-provoking stimuli is shown within each of the four age groups. (b) While individual situations show deviations, the increase of laughter response with age to five years, and the decrease in the sixth, is the trend most generally shown.

4. Of the three forms of presentation, actual situations were, in mean seconds of response, the most effective at all age levels. At three, four, and five years, the verbal presentation was next in effectiveness, and the pictures were least effective. At the sixth year, pictorial presentation was more effective than the verbal.

5. At all age levels, the mean seconds of response to situations in which the child himself participated was greater than the response to those situations in which he did not participate.

6. In general, though the girls are more responsive to laughter-provoking stimuli than the boys, the differences are not marked. Apparently, girls smile more than boys; boys laugh more than girls. Boys are more variable.

7. The greater responsiveness of the children in the upper occupational group in contrast with the lower is manifested consistently, though not markedly.

8. A positive relationship between I.Q. and laughter response is evident in this study. The relation of seconds of response to incongruity and I.Q. is perhaps most clearly indicated. Correlations with total seconds of

response at the various age levels suggest as a possible trend a decrease with age in the relationship between length of laughter response and I.Q.

9. A survey of the verbal responses and bodily movements produced by the laughter provoking stimuli indicated that the situations exemplifying the six main theories of laughter causation did involve, at least for some children, the elements they were designed to set forth.

10. It would be impossible to state that the elements which these situations endeavored to present were recognized as such by all the children, even by those who laughed. It would likewise be impossible to say that all those who recognized the elements laughed.

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The Preschool Child's Use of Criticism

Madorah E. Smith

ONE function of children's language listed in Piaget's classification is that of criticism. An investigation of this function is the subject of this study.

Approximately twenty thousand sentences spoken by children had been gathered in the course of another investigation. From these records of children two to six years old, all sentences expressing criticism of another child or of an adult were culled and analyzed in order to study the development of this use of language by little children. There were 325 such criticisms found. In comparing children at different ages a child was counted as two years old if his exact age lay between eighteen months no days and twenty-nine months thirty days inclusive. Another series of one hundred criticisms made by adults was gathered with the help of one of my classes in Teachers College, University of Hawaii to serve as a comparison with the main series.

There were very few criticisms made by the two-year-old children but there was only about one third as much material examined from children of this age as there was of each of ages three, four, and five and very little material, about one tenth as much, was available for children from sixty-six to seventy-two months of age. The more exact comparisons of children were therefore made between the three and five year olds for the most part.

Favorable criticisms composed a very small portion of the total, about eleven percent of them all. The difference between the proportion at three and five is insignificant but the four year olds used a number much smaller than at any other age and significantly less than did the five year olds. These criticisms—thirty-six in all—commented favorably on some person's dress three times, in eleven cases the person's actions or Hallowe'en mask or some other product of his skill was considered funny—funny, here being used with the idea of its desirability—in the remaining cases the person, his action, work or possession was said to be right, nice, cute, big—used as praise—, darling or good. Fifteen or 42 percent of these were spoken directly to the person criticised in contrast to only twenty-nine percent of all the criticisms to be thus directed. It would seem that even such young children have found it to be more discreet to direct favorable than unfavorable criticism to the person concerned.

The purpose of unfavorable criticism with the youngest children apparently was primarily to gain the assistance of some other person in a situation that was beyond their power of control. It was usually directed to an

adult in the hearing of the child criticised and partook of the nature of tattling. This was true of every one of the unfavorable criticisms of the two year olds.

The percentage of criticism made directly to the one criticised increased with age. The difference of 19 per cent between those of four and five years old is almost four times its probable error.

Apparently the younger children did not think their own criticisms would be of any use in obtaining their desires from the person criticised. They might ask or demand of him the object snatched away or the action desired but criticism was of no particular use except in securing the aid of another usually an adult.

At three, there was a beginning, five cases, of calling names or epithets as a relief to injured feelings that was directed to the culprit such as "You are naughty," "You are a crazy cat," "You're junk," "She's a lazy bone." This increased with the older children who also used a wider range of adjectives in describing the undesirable conduct of their companions to themselves or to others. They also commented in this fashion upon the conduct or personality of other children even when the conduct had very little effect on themselves. This type of criticism is included under the heading

CRITICISMS

	MADE BY CHILDREN AGED									
	2 years		3 years		4 years		5 years		60 to 72 months	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Number of criticisms	12		82		90		132		9	
Favorable criticisms	2	17	10	12	3	3	20	15	1	11
Unfavorable criticisms	10	83	72	88	87	97	112	85	8	89
Main consideration is effect on self	10	83	40	49	50	56	40	30	4	44
Interference:										
With self	8	67	37	45	38	42	37	28	4	44
With others			9	11	5	6	4	2	1	11
Total of interference	8	67	46	56	43	48	41	31	5	56
Failure to:										
Do as *I* wish			1	1	3	3	3	2	0	
Conform			7	9	13	14	14	11	1	11
Total failure to conform	1	8	8	10	16	18	17	13	1	11
Personal traits:										
Complained of because of effect on self	1	8	2	2	9	10	0	0	0	
Total personal traits	1	8	5	6	11	12	9	7	0	
Lack of skill or knowledge	0	0	13	16	17	19	45	34	2	22
Criticisms made:										
Directly to one criticised	2	17	17	21	19	21	53	40	3	33
Of which favorable	2	17	5	6	1	1	6	5	1	11

of unfavorable personal traits in the table. It composes but a small proportion of the criticism at every age.

By far the largest proportion of criticisms made by the children before five years is of interference with themselves or their possessions; such complaints as "That boy is mussing my sand all up," "You're spoiling the game," "He won't let me play," "He called me names," "You are always getting mine," "D. is right on your heels all the time," "C. hurt my sore arm," "E. stole my ball," are all listed under this heading. In most cases complaints are made only when some child interferes with the speaker but in a few cases particularly at three years complaint is made in behalf of another child; for example, "Daddy burned B's paper," "You'll make him deaf," (if you blow in his ear) "He hurt her," "This boy knocked A. on the nose."

The largest category of criticisms of the five year olds is that of another's lack of knowledge or skill or failure to produce a satisfactory result sometimes made to the child directly in an attempt to correct his error but more often apparently for the satisfaction of demonstrating the speaker's superiority. Examples of these are "Your dog has three legs," "You don't know how," "He can't tell names," "You swing me crooked," "He can't sing," "Such a dumb face," "Can't even blow it," "That's not your right hand," "You folks making this wrong."

COMPARISONS OF CRITICISMS

	MADE BY CHILDREN THREE AND FIVE YEARS OLD					MADE BY ALL CHILDREN STUDIED AND BY ADULTS				
	3 years		5 years		Difference	All children		Adults		Difference
	Number	Per cent	Number	Per cent		Number	Per cent	Number	Per cent	
Number of criticisms	82		132			325		100		
Made directly to person criticised	17	21±3.7	53	40±3.5	19±5.1	94	29±2.1		26±3.6	−3±4.2
Favorable criticisms	10	12±2.9	20	15±2.6	3±3.9	36	11±1.4		23±3.5	12±3.8
Unfavorable when main consideration was effect on self	40	49±4.5	40	30±3.2	−19±5.5	144	44±2.3		16±3.0	−28±3.8
Criticising:										
Interference with self or others	46	56±4.5	41	31±3.3	−25±5.6	143	44±2.3		5±1.8	−39±2.9
Failure to conform with social usage or desires of self or another	8	10±2.7	17	13±2.4	3±3.6	43	13±1.5		28±3.7	15±4.0
Undesirable personal traits	5	6±2.2	9	7±1.8	1±2.8	26	8±1.2		31±3.8	23±4.0
Lack of knowledge or skill	13	16±3.3	45	34±3.4	18±4.7	77	24±1.9		13±2.8	−11±3.4

The remaining type of criticism was that of failure to conform to the wishes of the one making the criticism as "You don't give me anything," "Nobody comes to buy" or more frequently, to conform to rules of conduct or the usage of the group such as "W. told bad stories," "He didn't say present," "Her say debbil," "You bof spilled," "You didn't do what mama wanted," "They aren't getting into line."

Criticisms of interference, failure to conform and personal traits were each separable into two divisions according to whether or not they had been made primarily because of the effect on the speaker of the action criticised. This consideration was most marked with the youngest children and a significant difference of nineteen per cent which is more than three times its probable error was found between the amount of such criticism made by three- and five-year-old children.

The proportions of all criticisms made by all the children from two to six years were also compared with the series of adult criticisms. The adults showed no difference in the amount of criticism directed to the person himself (though a higher percentage of criticisms thus directed were favorable) but criticism not so directed was more in the nature of "talking behind their backs" than of tattling and was not within hearing of the person criticised as was most of that made by the children. The adults' criticism of interference was almost negligible and significantly less in proportion than the children's while the significantly larger proportions were of undesirable traits and of failure to conform. Of the latter type one particularly large subdivision was that of dress. Of the one hundred criticisms collected, nineteen commented unfavorably on dress or makeup and nine favorably while only nine of the 325 child criticisms mentioned dress either favorably or unfavorably. The criticisms of personal traits were much more abstract and used adjectives almost entirely rather than frequent nouns as did the children's criticisms of this nature. Only five of the thirty-six criticisms of this type were made directly to the person concerned and they probably were considered to be of a less serious nature than those not so directed such as changeable, "got your nerve," "you're both hot-tempered" as compared with snobbish, sarcastic, rude, frivolous, lazy, careless, lacks self-respect. The group of criticisms of lack of knowledge or skill was significantly less in proportion than in the case of the children, only thirteen cases in all, of which six complained of lack of skill in some game. All but one of these were unfavorable and were made to the blunderer himself in contrast to not one unfavorable made to the person criticised for lack of knowledge or skill in other lines. Is it possible that our emphasis on good sportsmanship in games and sports has made it possible for our friends to dare to make their criticisms in this field to us directly where it would supposedly be of most value? One improvement the adults made was an increase of twelve per cent which was three times its probable error, in the proportion of favorable criticisms.

SUMMARY

1. A study of the criticisms made by children of two to six years old showed four types of unfavorable criticisms made;—interference with self or possessions, failure to conform to wishes or social usage, lack of knowledge or skill, and undesirable personal traits.

2. The amount of criticism found in records of complete conversations increased slightly but regularly from two to five years.

3. At first criticism was directed to another than the person concerned apparently for the purpose of securing help in a difficult situation and partook of the nature of tattling.

4. A significantly greater proportion of criticisms was made at five than at three years old, directly to the person criticised.

5. At every age the unfavorable criticism greatly exceeded the favorable.

6. The most frequent complaints were of interference and lack of knowledge; the former decreasing and the latter increasing significantly with age from three to five. Failure to conform and undesirable personal traits were complained of most frequently at four but the difference at different ages was not significant.

7. Most of the criticisms made by children were made primarily because of their effect on the speaker, but the percentage of such criticisms lessened significantly from three to five years.

8. A series of criticisms made by adults and collected for the purpose of comparison showed a significant increase in the proportion of criticism of personal traits, of dress, of failure to conform and of favorable criticisms with a significant decrease of criticisms of lack of knowledge or skill and of interference.

9. But there was no significant difference in the amount of criticism directed to the person criticised; that made to another however was of the nature of "talking behind their backs" rather than of "tattling."

A Study of Emotional Instability in Nursery School Children

Mary A. M. Lee

"Nervousness" is a term that needs elucidating. For some it means muscular activity of a generalized or special sort, restlessness or tics. For others it means a neurotic trend, a predisposition to psychopathic manifestations, such as excessive fears, or hypochondriasis, or perhaps only the more obvious behavior anomalies of temper tantrums, feeding problems and similar habitual ways of controlling the environment. For many it is synonomous with emotional instability, a more than average lability of those reflexes which involve the visceral and somatic mechanisms associated with a change in feeling tone. Although it would be futile to determine the relative validity of these definitions it is probably not unreasonable to suppose that the last one represents at least one element in what may be a very complex trait or habit syndrome. Scientifically, at any rate, it has the practical advantage of being capable of direct measurement. By converting the question "Are there individual differences in the ease with which children are upset emotionally?" into "Under the same general conditions do some children give evidence of more shifts of mood as judged by their facial expressions than others?" we may hope for an answer. We may also determine the relation of this frequency of shift of mood to average mood level, to judgments of nervousness and to various established measures of the children. We may attempt too to determine what general environmental factors affect this lability of mood and the mood level in all children and in what ways they affect them. With these aims the present investigation was undertaken at the University of Chicago Coöperative Nursery School in the winter of 1930–31, and financed in part by the Department of Home Economics, a preliminary study of the same nature having been carried out as a class project in the fall of 1929.

The group observed was the youngest at the Nursery School and consisted of 18 children, 9 boys and 9 girls, between two and three years old. Complete health records were available and, except in a few cases where adequate coöperation was not secured, their mental age had been measured by the Kuhlmann scale, the range in the group being 25.8 months to 46.4 months. The observations consisted in three-minute graphic records of shifts of mood, such records being taken at varying hours according to a prearranged schedule so as to con-

stitute as far as possible a random sampling of the child's behavior. In order to avoid a possible tendency to observe the most available or the most conspicuous child, the order was fixed for each observer and was changed each day. In all, 995 records were made and scored as to total number of times a shift occurred from one to another scale division of mood, and also as to the algebraic sum of average feeling tones in each quarter minute. (Figure 1.) Although the observations were made as far as possible when the child was at free play, 44 were made in whole or part in the toilet or cloak room. Five hundred and sixty-six records were made indoors and 429 outdoors, of which 229 were on sunny days and 200 on overcast days. No clear grouping could be made on the basis of temperature or humidity conditions outdoors or in, or of other doubtless important factors depending upon weather conditions.

The observers X, Y and Z were three graduate students in Home Economics all of whom were engaged in some other capacity in the nursery school. There was first a preliminary practice period during which simultaneous observations were made and a seven point scale of mood level objectified as much as possible by discussion of individual cases. At the end of the experiment simultaneous observations were again made to check agreement. The average discrepancy between records taken at the same time was 3.7 per cent for shifts of mood and 7.6 per cent for mood level. X observed from 9:00 to 10:00 a.m. and made 122 observations, Y made 441 observations for the most part between 10:00 and 11:00 a.m. and Z 432 observations between 11:00 and 12:00 a.m. After four weeks X was forced to withdraw from the experiment because of illness and later Y observed from 9:00 to 10:00 a.m. Since there was thus considerable

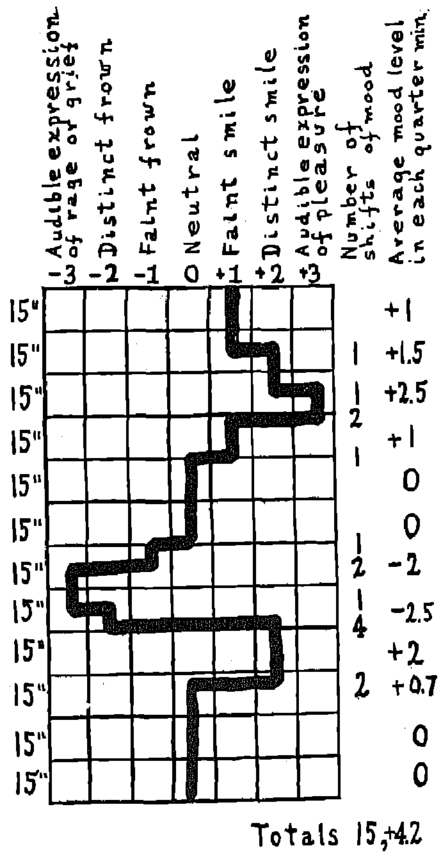

FIG. 1. TYPICAL RECORD

difference in the environmental conditions under which the observers made their records, no high correlation could be expected between them. Between the final rank orders ascribed to the children by X, Y and Z we find an average r of .447 in shifts of mood and .420 in mood level.

The experiment extended over thirteen weeks. Comparing the averages of the individual scores obtained the odd weeks with those obtained the even weeks by the method of Rank Differences $p = .7201$ or $r = .7363$ in shifts of mood, and in mood level $p = .7752$ for which the corresponding r is .7857. Correcting by Brown's Formula the reliability of the test as a whole becomes $.8481 \pm .0446$ for mood shift and $.8800 \pm .0398$ for mood level.

For comparison of the individual scores with other physical and mental measures, only those 13 cases were considered of which over 50 records were made. In this array there is an intercorrelation of $.497 \pm .147$ between the average mood level and the average number of shifts of mood, indicating that the more reactive individuals were on the whole the more cheerful. Frequency of shift of mood correlated with a rating by the teacher in charge as to "nervous instability" $.528 \pm .141$. The only other correlations which were large enough to be significant were between mental age and mood shift and mood level. These were $.563 \pm .134$ and $.482 \pm .150$ respectively. Low positive correlations obtained with weight but practically none with general health or chronological age, the latter finding being perhaps accounted for in part by the small range in our group.

In the preliminary class experiment extending over six weeks and engaged in by eight less trained observers a consistent difference was found between Monday and Tuesday scores. In every case the children showed greater stability of mood on Tuesday. Little more than a tendency in that direction is shown in our present experiment, the most constant change being in the direction of increased instability at the end of the week. No consistent change was found in mood during the week. (Table 1.)

There was a tendency for children to be more stable and happier when at free play than if urged by adults to take off coats, wash hands etc., but this was true for only 8 of the 14 children observed in both situations and our observations in the locker room were few. When indoor and outdoor free play are compared we find all but 4 of the 17 children are more unstable outside, but the effect upon mood level is less general. When the sun shone outside 12 of 15 children were

TABLE 1

Average number of shifts of mood and average mood level for different days of week

DAY OF WEEK	SHIFTS OF MOOD	MOOD LEVEL
Monday	7.44	2.31
Tuesday	6.84	2.39
Wednesday	7.17	2.29
Thursday	6.94	2.83
Friday	9.35	3.12

TABLE 2

Average scores under various conditions

	NUMBER OF MOOD SHIFTS	MOOD LEVEL
Inside, locker room	8.02	1.69
Inside, free play	6.79	2.41
Outside, free play	8.13	2.81
Outside, sunny	8.73	3.03
Outside, cloudy	7.44	2.56
With Mother present	10.15	1.09
General average	7.42	2.55

more unstable and all but 5 were happier. On the days the mother was present all but two of the children were less happy and more unstable. The change in amount and character of the stimulation associated with these environmental factors apparently affects the relatively stable as well as the very reactive child. (Table 2.)

We may conclude (1) that instability of mood and mood level are measurable characteristics of nursery school children, (2) that they are interrelated in the nursery school situation, (3) that they correlate more highly with mental than with physical age or health, and (4) that they tend to be affected in definite ways by environmental factors.

Factors Influencing Friendships Among Preschool Children*

ROBERT C. CHALLMAN

INTRODUCTION

THE fact that friendship is an everyday social phenomenon does not imply that its causation is known or understood. The determiners for the selection of friends have usually been thought to lie in the possession of similar tastes and interests, common likes and dislikes, and to propinquity. The bearing of these particulars upon friendships is to a great extent unknown as yet. It seems quite certain that the approach to the solution of the problem cannot be effected by a simple questioning of mutual friends. It is likely that Almack (1) is correct in saying that the selection of friends is probably not consciously effected, and that "there is grave doubt whether reasons which are given to explain the formation of friendships are real reasons."

It would seem that an observational technique offers a worthwhile approach to the problem, and that the nursery school of an Institute of Child Welfare offers an ideal situation for the use of such a technic. In the first place, in such an institution a number of children are congregated, each child having, theoretically, an equal opportunity to associate with every other child. Secondly, there is an almost ideal environment for the observation of groups because the children are accustomed to the presence of strange adults; the area for play is limited; and the enrollment of the school is fixed. Thirdly, the number of times one child is with another can be used as an objective measure of the strength of the friendships, and other measures of various kinds can be made with relative ease for the purpose of correlation.

PURPOSE

The primary purpose of this study is to discover what factors in addition to propinquity, which is held fairly constant, operate in determining the friendships of young children. It is generally assumed that similarity in traits is conducive to the formation of friendships; therefore this investigation is principally concerned with the extent to which closeness of friendship is influenced by similarity in various particulars. The items selected for scrutiny as having a possible bearing were the following: likeness in sex, chronological age, mental age, intelli-

* From the Institute of Child Welfare, The University of Minnesota. The writer wishes to thank Florence L. Goodenough, who suggested this study and acted as statistical adviser, John E. Anderson, Josephine C. Foster, and Charles Bird.

gence quotient, height, attractiveness of personality, and degrees of extroversion, sociality, physical activity, laughter, and social participation.

SURVEY OF THE LITERATURE

Few studies have been made in this field of social relations, and some of these have not been entirely satisfactory in technique. Two studies have dealt with adolescent friendships. One was by Warner (7) who found that 66 delinquent boys, presumably adolescents, grouped in gangs and in pairs tended to be slightly more alike in M.A. than in C.A. Williams (9) in a questionnaire study of 84 adolescent boys in a school for delinquents, who ranged in age from 12 to 17 years, and in mental age from 9 to 15.5 years, found a tendency for friends to be of about the same C.A. and M.A. Neither of these studies is adequately treated statistically.

Three studies of older school children have been made. Wellman (8) using an observational method by which she selected as friends the pairs of children seen most frequently together, studied 29 pairs of boys and 27 pairs of girls in the 7th, 8th, and 9th grades. Her study indicates that pairs of girls are more alike in scholarship, physical achievement, and extroversion and less alike in height, and C.A. Boys, on the other hand, are more similar in height, C.A., and I.Q. and less alike in extroversion, scholarship, and M.A.

From 387 school children in grades four to seven Almack (1) obtained the names of the boy or girl each child would choose to help him if he were given some work to do for which the person was well fitted. Each child was also asked to name the boy or girl he would first invite to a party. The correlation coefficients between the C.A.'s of the children and the C.A.'s of those with whom they chose to work was .53; between M.A.'s .54; and between I.Q.'s .41. The coefficient between the C.A.'s of the children and those of the invited boys was .50; between M.A.'s .54; and between I.Q.'s .32. The corresponding coefficients for the invited girls were C.A. .42, M.A. .50, and I.Q. .30. He concludes that there is a tendency for children of these ages to select associates from their own mental level.

Sixty-two pairs of pre-adolescent chums comprising 35 different individuals having a mean C.A. of 9.5 years (S.D. 17.9 months), were studied by Furfey (4). The obtained correlation coefficients between chums are as follows: C.A. .39, Developmental Age .37, height .34, M.A. .24, and weight .22. The probable errors are $-.07$ for the first two and $-.08$ for the rest. His conclusion is that there is a tendency for boys to choose chums of the same size, age, intelligence, and maturity as themselves.

A quite comprehensive study of spontaneous groups of preschool children somewhat similar to this one was made by Chevaleva-Janovskaja (3) in Odessa. She investigated 888 groups composed of 276 children. It was discovered that more boys participated in groups than girls, i.e. of 100 boys, 68 participated in groups, but of 100 girls only 56 did so. It was also found that the mean for participation in groups increased with age from 7.16 at 3 years to 11.9 at 4, and 12.25

at 5 years. In 67 per cent of the groups, the children were of the same age or differed by a year, and in only a little over one per cent was the difference as much as four years. She states that the tendency to join with a child of little different age is more marked in boys than it is in girls, and that children of three to five years of age form bi-sexual groups more often than unisexual. When unisexual groups were formed they were usually masculine. She also found that some kinds of play material favored the formation of groups of equal age particularly in the higher age groups.

SUBJECTS

Thirty-three children, 17 boys and 16 girls, in the nursery school of the Institute of Child Welfare at the University of Minnesota were used as subjects. The means and S.D.'s of the chronological ages and mental ages in months, the intelligence quotients, the height in centimeters, the attractiveness of personality to adults in total scores as obtained by a rating scale, the degree of extroversion in terms of the combined ratings of 12 judges using the Marston Scale, the degrees of sociality, physical activity, and laughter expressed in sigma scores, the degree of social participation, the occupational class, and the friendship indices for the boys and for the girls are given in table 1. The means and ranges for the same items are also given for the combined sex groups.

TABLE 1

Means and S.D.s of boys and of girls, means and ranges of combined sexes on various items

	GIRLS		BOYS		BOTH	
	Mean	S.D.	Mean	S.D.	Mean	Range
C.A.	43.2	7.7	44.5	8.3	43.8	27.1– 59.4
M.A.	48.9	10.6	48.7	13.8	48.8	30.0– 74.0
I.Q.	112.7	10.3	108.5	16.3	110.5	77.0– 160.0
Height	100.5	6.2	100.3	5.0	100.4	89.5– 110.6
Personality	32.1	8.3	30.7	10.3	31.4	14.0– 50.0
Extroversion	779.0	116.0	812.0	161.0	796.0	491.0–1047.0
Sociality	3.02	.33	2.98	.34	3.00	2.24– 3.41
Phys. Activ.	2.88	.19	3.11	.26	3.00	2.41– 3.39
Laughter	3.02	.16	3.00	.25	3.00	2.74– 3.50
Soc. Partic.	5.85	1.1	4.92	1.2	5.39	3.25– 8.66
Occ. Class	2.82	1.4	2.88	1.4	2.85	1.0 – 5.0
Friendship Indices	.32	.14	.23	.17	.15	.02– 1.9

It can be seen by an examination of this table that in intelligence quotient and height, these children are slightly better than the average. They are also superior to the average in socio-economic status and are more extroverted than the group Marston used. In comparing the means of the boys and girls, we find that the groups are practically equal in respect to age, mental age, intelligence quotient, height, sociality, laughter, attractiveness of personality, and occupational class. The boys are more active physically. The girls are more active

socially and have a higher mean friendship index. The latter may be owing to the fact that boys are more often alone and that they form smaller groups. No significant differences between the sexes in variability were discovered although the differences found were mostly in the direction of greater variability among the boys. The differences in variation in M.A. and I.Q. appear rather large, but they were in the main due to two extreme cases in the boys' group.

METHOD

The general method was the observation and notation of the names of the children who were found in the same group at the free play hours. During these periods the initiation and control of activities by the teachers are at a minimum. A group was considered to exist when two or more children were in close spatial relationship more or less isolated from other children or when they were mutually engaged in the same activity. When fifty per cent or more of the membership of a group was changed, it was called a new group. Those groups whose membership had been influenced by teachers were omitted.

Two slightly different methods of notation were used. The writer's method was to enter a room and note down the names of the children who were together in groups. Any child who was in a group for fifteen seconds was considered a member. In practice, this minimum was seldom used, as practically all the children who were counted were together for at least one minute. When all groups were noted, he went to the other rooms and followed the same procedure until all the groups had been recorded. Then he re-entered the first room and started over again. It usually took about five minutes to make the rounds and in any case identical groups were not recorded until five minutes had elapsed from the time they had been last recorded. Nine other observers, in connection with various observational studies (5), also noted down the names of the children in the same group with the child they were observing. The observations were made between October fifteenth and November eighteenth, 1928. Over 200 hours were spent in observation, and 7,248 groups were recorded.

Although the observational method is believed to have the most advantages in approaching this aspect of social relations, there are some sources of error which should be mentioned. That children were counted as in the same group even though they were paying little attention to each other at the time results in a small error, but as this kind of group constituted only a small percentage of the total groups it is possible that more error would have been introduced by interpreting the quality of the group than by counting all in more or less isolated groups as members. It is also impossible to know to what extent chance operated in the formation of groups. The mere fact that a child enters a certain room upon arriving at the nursery school might influence at least the first few groups he becomes associated with. Besides this, certain other groups that were largely chance groups were included in the tabulations. These, the mid-afternoon

lunch group, the structure of which depends largely upon the time of waking from the nap, and the groups that were being dressed for going to the playground were found to comprise 7 per cent of the total number of groups.

Another source of error is that two methods of observation were used, one by the writer, and another by the nine observers. This may have lowered the reliability of the method to some extent. In 23 or 70 per cent of the cases, however, each child's strongest friend, as found by the writer, was the same as that found by the other observers. In 8 or 24 per cent of the cases the child who was found to be the strongest friend by the writer was found to be the next strongest by the other observers. In two cases there was a discrepancy of three and four places respectively, but in these cases no definite preference was shown for any child. The same held to a lesser extent in the 8 cases cited above. It is the writer's belief that a truer measure was obtained by the use of records from the nine additional observers in consideration of the fact that the number of groups is increased so greatly.

Perhaps the most important source of error lies in the fact that, when children are engaged in the same activity, it is impossible to know to what extent they are attracted by the specific play material and to what extent they are attracted by the children in the group. With the present technic, the exact weight of each factor cannot be ascertained. It is probable that both factors are operating. That the associates are more important can be inferred from the fact that the same group from time to time will engage in a variety of activities.

TREATMENT OF DATA

After the observations had been completed, a tabulation was made of the number of times each child was found in the same group with every other child by each observer. These were summed; thus the total represented for each child the number of times he was found with every other child. In order to equate absences, each of these totals was divided by the number of hours of observation made at times both children were in attendance at the nursery school. For example, Child A was found with Child B 150 times. They were both present on 30 specific days, and 100 hours of observation were made on those days. Thus the number of times per hour the two children were together is 1.5. This number (1.5) and others similarly derived for every possible pair of children serve as a quantitative measure of the strength of friendships. Hereinafter they will be referred to as friendship indices. The total number of indices was 528.

These friendship indices were distributed with pronounced positive skewness as is shown in figure 1. This non-normality of distribution is to be expected in dealing with such data since each child is apt to make a relatively weak association with almost every other child in the nursery school and to have only one or two strong friendships. The points representing the strong friendships can be seen strung out along the abcissa. Another

factor operating to produce the skewness is the inclusion of chance groups amounting to 7 per cent of the total number. These were not excluded because at the time of the tabulation the present treatment of the data was not contemplated. The inclusion of these chance groups would increase the number of relatively weak friendships more proportionately than it would the strong ones, as can readily be seen.

the lower scores. It does not bring into play any spurious relationships, nor does it tend to raise the correlation.

The differences between the scores of each child and every other child was next obtained for the various items. The records of chronological age, mental age, intelligence quotient, and height were taken from the files of the Institute of Child Welfare. The score for social participation was obtained

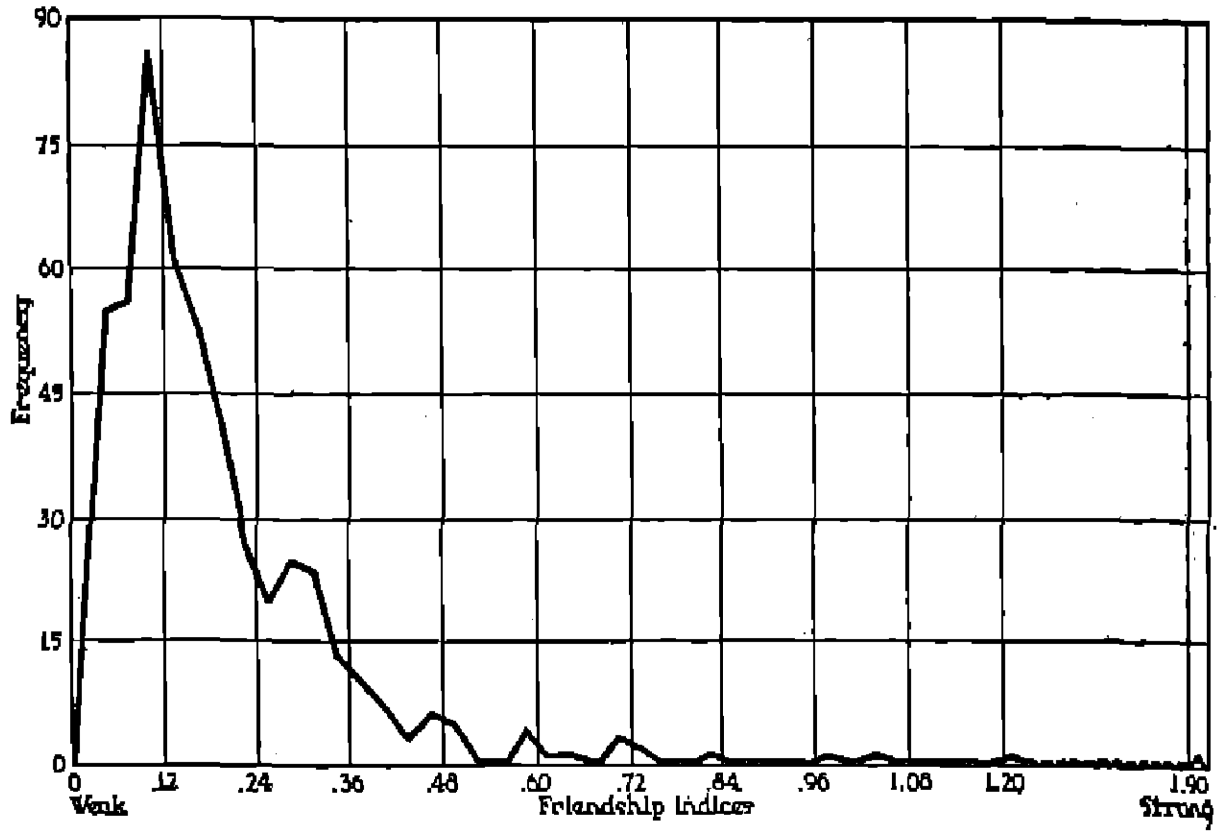

FIG. 1. FREQUENCY POLYGON SHOWING ORIGINAL DISTRIBUTION OF FRIENDSHIP INDICES

As the found distribution could not be grouped into class intervals because of its extreme range, it was thrown into a normal one by adjusting class intervals to fit it, thus making the data subject to correlational treatment (6). This transformation scheme is empirical but it should be noted that it tends mainly to draw in the upper extreme and to displace somewhat toward the middle the distribution of

by dividing the total number of children the child was associated with by the number of hours he was present and observed. The method of obtaining the scores for attractiveness of personality, extroversion, sociality, physical activity, and laughter is explained in the article by Goodenough cited above. The reliabilities for the first two (ratings) are high, being .95 and .98 respectively, but the reliabili-

ties of the observational studies are not so high, being .76, .86, and .83 respectively.

When the aforementioned differences between every possible pair of children on these ten items were found, they were correlated with the friendship indices. Thus, for example, the differences in age (found by subtracting each child's age from that of every other child) was one variable and the friendship index the other. Herein lies the difference in method between this study and that of previous ones. In other studies, pairs of strong friends only were selected and their traits were correlated, the idea being that any significant difference from zero would indicate an influence of the trait in question on friendship. There was no measure of the strength of the friendship. In this study, friendship is conceived as a continuous variable existing in different amounts. Each child is believed to have some degree of friendship for every other child; antipathies, if present, are expressed by friendship indices of low magnitude. In this way, the correlation coefficients when all the children are used is based on 528 relationships, not 33 cases.

It became evident soon after the computation of the data was begun that the sex of the children had a very strong influence on the strength of their friendships; so the children were divided into four groups: (1) boys with boys, (2) girls with girls, (3) boys with girls, and (4) all children, in which every child was included. Pearsonian product-moment correlations were then calculated within each group. Pearsonian r's were also calculated between age (not closeness in age) for the groups mentioned above, and biserial r's were calculated between strength of friendship and like and unlike sex for the lower and upper age groups and for all the children. To supplement these correlations, the pairs showing the strongest reciprocal friendships, four pairs of girls and three pairs of boys, were selected. The average of the differences petween these children in the various items (C.A., M.A. etc.) the pairs of boys in one group and the pairs of girls in the other, was computed. These averages were then compared with the average of the differences among all the rest of the children, boys and girls taken separately, including the friendships between the children in the reciprocal friend group with all other children except each other. The formulae for finding the significance of a difference were then applied, the difference over the standard deviation of the difference being used.

RESULTS AND CONCLUSIONS

Influence of C. A.

Table 2 shows the correlations within the different groups between increasing age and strength of friendships. These coefficients show that boys have a slight tendency to associate with other boys as age increases, and also that they tend to associate with special ones. It would seem that the same tendency is shown in the coefficient for boys with girls, but the scattergram shows that two boys over 56 months were responsible for most of the correlation. When these are omitted, the correlation drops to .10.

Girls show no particular tendency to associate more with other girls, or boys, nor with certain ones as age increases. At first glance, these results seem somewhat different from those obtained by Chevaleva-Janovskaja, as she found that the means for participation in groups increased with age. There is only an apparent discrepancy, however, as the correlation between social participation and age is .30 which is in accord with her findings. The fact that these correlations are low has a certain value in that it shows that the correlations found with similarities in other traits are not merely a function of increasing age. The only correlations that can be questioned are those in the boys-boys group. A correlation of .24, however, particularly when it is of the second order, would not in the writer's belief have a very decided effect on the coefficients.

TABLE 2
Effect of increasing age on strength of friendships
(r C.A. with F.I.)

INDIVIDUALS CORRELATED	r	P.E.
Boys with boys............	+.24	±.04
Girls with girls............	+.03	±.04
Boys with girls............	+.30	±.04
Boys with girls (56–58 mos. omitted)................	+.10	±.04
Girls with boys...........	+.07	±.04

Influence of Sex

The most unexpected result in this study is that even the youngest children discriminate very decidedly in their friendships on the basis of sex. Only one boy, a child of thirty months, was more often with girls than with boys, and only one girl twenty-six months old showed even a marked tendency to form friendships with children of the opposite sex. The biserial r for the youngest age group (27 to 45 months) is .53, for the highest age group (46 to 59 months) .56, and for all the children .55. The result for the youngest group are presented in figure 2. Here it is shown that in only eight per cent of the cases are friendships between unlike sexes stronger than the median strength of those between like sexes, while eighty-two per cent of the like-sex friendships exceed the median of those of the unlike sex. In the upper age group the corresponding figures are 5 and 84, and the results are very similar when one curve is drawn for all the children. This finding seems opposed to the statement of Chevaleva-Janovskaja (3) that children from three to five years of age form more bisexual than unisexual groups. As no quantitative expression is given to back up this assertion, it is hard to determine its validity. It is possible, however, for both her statement and the writer's finding to be true because many of the bisexual groups may have consisted of a large majority of one sex with one or two children of the other. If this is true, then it could happen that each sex keeps mainly to itself and yet more bisexual than unisexual groups are formed.

Influence of similarities on strength of friendships

Before discussing the significance of the correlation coefficients given below, consideration of the conditions affect-

ing their magnitude should be given. The following items tend to lower the obtained coefficients: (1) the inclusion of 7 per cent known chance groups; studies of sociality and physical activity; and (5) the influence of play material in the formation of groups. Thus it is reasonable to suppose that

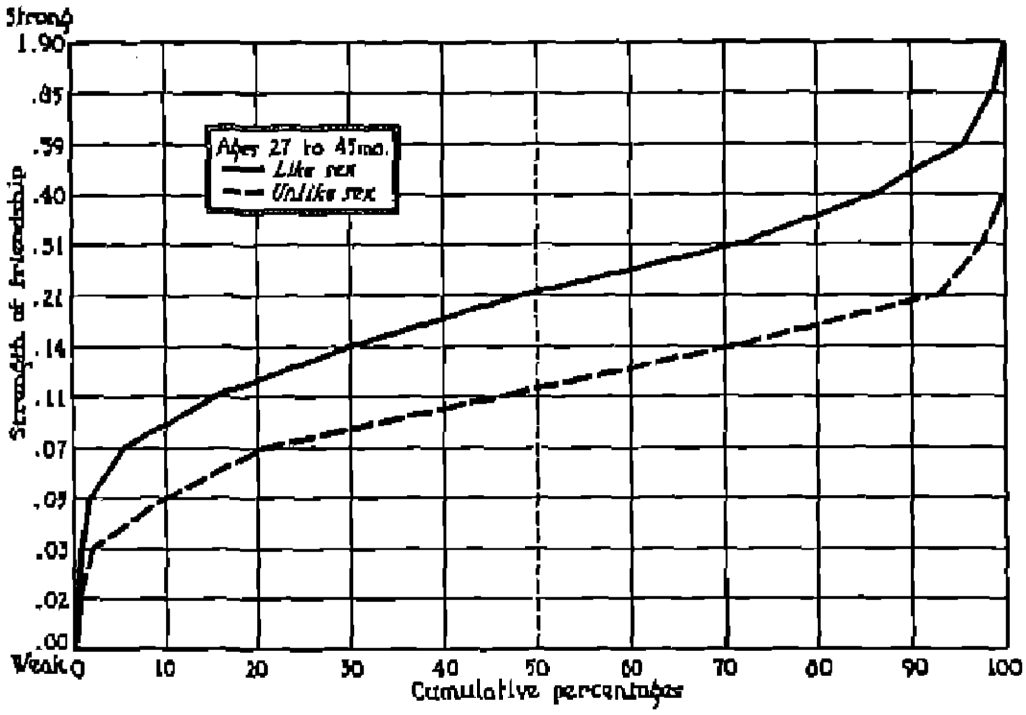

FIG. 2. OGIVE SHOWING STRENGTH OF FRIENDSHIP BETWEEN LIKE SEXES AND UNLIKE SEXES EXPRESSED IN MAGNITUDE OF FRIENDSHIP INDICES

TABLE 3

The correlation coefficients between similarity in various items and closeness of friendship for boys with boys, girls with girls, boys with girls, and all children

	B-B	G-G	B-G	ALL
N	136	120	272	528
C.A.	+.502 ± .039	+.348 ± .053	+.205 ± .037	+.207 ± .020
Soc.	+.504 ± .043	+.346 ± .053	+.150 ± .039	+.252 ± .027
Phys.	+.355 ± .050	+.227 ± .058	−.082 ± .040	+.220 ± .028
Soc. P.	−.109 ± .067	+.430 ± .050	+.055 ± .041	+.114 ± .028
M.A.	+.264 ± .054	+.158 ± .060	+.182 ± .030	+.183 ± .028
Ht.	+.228 ± .054	+.190 ± .059	+.065 ± .044	+.085 ± .020
Ext.	+.010 ± .058	+.284 ± .057	+.157 ± .031	+.130 ± .020
Pers.	−.038 ± .057	+.201 ± .059	+.107 ± .041	+.058 ± .020
I.Q.	−.001 ± .058	+.161 ± .059	−.045 ± .040	+.040 ± .029
Laugh	−.069 ± .058	+.051 ± .001	−.125 ± .040	−.040 ± .020

(2) the inclusion of unknown chance groups, probably of no great moment; (3) physical proximity taken as one of the criteria for the existence of a group; (4) the none too high reliabilities of the the correlations found are minimal, and that in all probability they should be higher.

Table 3 shows the coefficients obtained in the different groups when

similarities in the items were correlated with closeness of friendship. In table 4 are presented the critical ratios between the mean differences of reciprocal friends on the selected items and the mean differences of the rest of the children. These two tables will be discussed together as they supplement each other.

General trends of the data

Considering the tables as wholes, the following trends may be seen. The correlation coefficients in the first column (Boys-Boys) are both higher and lower than those in the second (Girls-Girls). That is, there are two coefficients of .5, one of .3, two of .2, one of .1 and four approximating .0; in the second column, however, there are one of .4, two of .3, three of .2, three of .1, and one approximating .0. One might infer from these data that certain traits are quite important in the formation of boys' like-sexed friendships and that other traits have negligible significance. With girls' friendships on the other hand fewer traits are of primary importance and more traits have some significance. Secondly, the coefficients in the third column (Boys-Girls) are almost uniformly low, that with C. A. being the only one of possible significance. This points to the conclusion that similarities or differences between children of unlike sex, at least in the items studied, have little to do with formation of friendships between them. This conclusion, if justified, also explains the lowness of the correlation coefficients in the fourth column in which sex is disregarded. Because these coefficients are masked, by the sex factor, they will not be considered further in this paper. Thirdly, it should be noted that the critical ratios in table 4 with one exception bear out the trends of the results when the boys' group is compared with that of the girls'.

TABLE 4

The critical ratios between the mean differences of reciprocal friends on various items and the mean differences of the rest of the children

	B–B	G–G
N	6	8
C.A.	8.38	.72
Soc.	7.08	10.55
Phys.	4.80	*.86
Soc. P.	.17	2.43
M.A.	1.95	.16
Ht.	2.71	1.53
Ext.	*.46	*.85
Att of Pers.	.80	4.02
I.Q.	.02	.48
Laugh	.05	2.89

* The starred figures represent differences of means in the opposite direction.

Closeness of chronological age and closeness of friendship

That boys show a distinct tendency to make friends with boys of like age, and that girls show the same tendency

to a lesser degree is evident in the coefficients of .562 and .348 in table 3. Also, in table 4, a very significant difference between the average of the differences between reciprocal boy friends and that among the rest of the children is found, while with girls, the difference is not significant. This non-significance is to some extent owing to the fact that one of the friendships was between girls who lived next door to each other and who differed in age by over a year. Similarity in age was found to be an important factor by Wellman in her work on junior high school students and by Chevaleva-Janovskaja on preschool children. Both investigators found that it was of more fundamental importance in boys' friendships than in girls'. The reason for this sex difference is not so easily found. Facts which may have some bearing are that girls play "family" much more than boys, a game that necessitates a much younger child for the baby; older boys engage in vigorous activities in which the younger boys cannot participate. The writer does not believe, however, that these two facts offer a complete explanation, particularly in view of the findings with older children.

Closeness in sociality and closenesss of friendship

As the correlation coefficients indicate, there is a definite tendency for both boys and girls to form friendships with like-sexed children similar to themselves in sociality. There is a discrepancy between the two tables, however, in the direction of the importance of the trait. Table 3 indicates that the trait is more important in the friendships between boys, and table 4 that it is of greater import in the friendships of girls. In view of the number of cases involved in the two tables, it is probable that the correlation coefficient is the more correct, and that some chance influence is operating in the friendship of the four pairs of girls.

Certain facts about the play interests of children have a bearing on this finding. "Sociality" is more or less a measure of the degree of organized coöperative activity. Thus those children who like coöperative activities are apt to play together and to become friends. Boys on the one hand, as Bridges (2) has shown, prefer activities like building with bricks, cube construction and the like, activities that can be carried out with others who like the same kind of occupation, while girls tend to prefer threading beads, color matching, and the like, activities not so readily performed in coöperation. These facts help to explain the higher correlation between sociality and friendship among boys and the lower one among girls. Of course, the relationship may work the other way, that is, a preference for organized activities might tend to bring together certain boys because they prefer the activity and not the children engaged in it.

Closeness in physical activity and closeness of friendship

Likeness in physical activity does not exert so great an influence on strength of friendships as does age or sociality, but it does affect the friendships of boys with each other in some degree and in those of girls it is just

perceptible. With reciprocal friends the same result can be seen, it being all the more evident that similarity in physical activity is less important with girls.

These results are more or less what one would expect. Bridges (2) found that three-year-old boys prefer activities requiring large movements and involving a marked output of physical energy, whereas girls prefer activities involving finer movements and requiring little exertion. It would be natural, then for boys to prefer as their companions other boys similar to themselves in physical activity who would play games at a similar level. With girls, this would not be so true.

Closeness in social participation and closeness of friendship

As will be remembered, the score for social participation was obtained by dividing the number of children each child was with by the number of hours he was in school and observed. Thus the participation score is the average number of children per hour each child was associated with. The correlation coefficients as well as the critical ratios show that boys who mix with about the same number of children have no tendency to become friends. In other words, the solitary boy does not tend to become friends with other solitary boys nor do gregarious boys make friends with others of the same stamp. With girls, on the other hand, the tendency is reversed. They tend to form friendships with other girls of about the same degree of social participation.

Closeness in mental age, height, and closeness of friendship

If age were held constant, the coefficients between these two items and strength of friendship would probably drop to approximately zero, as the correlation between closeness in I.Q. and closeness of friendship indicates. The critical ratios are not significant either, which confirms the supposition. It is likely, then, that mental age and height have no influence on friendships.

Closeness in extroversion, attractiveness of personality, I.Q., and frequency of laughter and closeness of friendship

All these coefficients are too small be significant, and table 4 shows that reciprocal friends have very little tendency to be alike in these characteristics. These results might be expected from an a priori standpoint, at least in respect to laughter and I.Q. One might expect, however, that children similar in attractiveness of personality would be friends, and this tendency may be present to some extent in the friendships of girls (r = .201 $\pm$.059, critical ratio 4.02), but its influence if present is very slight. The fact that attractiveness was rated by adults and the probability that a child with an attractive personality might attract other less attractive children also cast doubt on its influence on preschool friendships.

SUMMARY

A study was made of the factors in addition to propinquity that influence the formation of friendships among

preschool children. Thirty-three nursery school children, 17 boys and 16 girls, ranging in age from 27 to 59 months were used as subjects. The method was the observation of groups, the number of times each child was with every other child being used as the criterion for strength of friendship. The items selected for study were likeness in sex and similarities in C.A., M.A., I.Q., height, attractiveness of personality, and degrees of extroversion, sociality, physical activity, laughter, and social participation.

The following results were obtained. (1) Boys have a slight tendency to form stronger friendships with other boys as they grow older. ($r = .24 \pm .04$). This tendency is not present in the boys' friendships with girls nor in girls' friendships with each other. (2) There is a marked cleavage in friendships on the basis of sex, children of each sex tending to form friendships within their own sex. (3) None of the items investigated with the possible exception of C.A. has any influence on friendships between boys and girls. (4) Similarities in C.A., sociality, and physical activity have an influence in the order given on the friendships of boys with boys. (5) Similarities in social participation, C.A., and sociality and possibly physical activity influence the formation of friendships between girls in the order given. The correlation coefficients are lower in the case of C. A., sociality, and physical activity than are the corresponding ones of the boys, a fact which indicates a lesser influence. (6) Similarity in mental age, height, extroversion, attractiveness of personality, I.Q., and frequency of laughter have no influence on either boys' or girls' friendships.

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A Study of Sleep Habits of Two Groups of Preschool Children, One in Hawaii and One on the Mainland

ALIDA VISSCHER SHINN

PROBLEM AND METHOD

In THIS study the following major problems, dealing with the sleep of children from 1 year to 6 years of age, have been considered:

1. How long does it take children to go to sleep at nap?
2. How long do children sleep during the nap?
3. How long does it take children to go to sleep at night?
4. How long do children sleep at night?
5. How long is the total sleep?
6. How does the median total sleep of Vassar College Nursery School compare with Castle Kindergarten?
7. How does weight correlate with total sleep?
8. How does nap correlate with night sleep?
9. How does mental age correlate with total sleep?
10. Is there any special rhythm to total sleep?
11. How does the humidity affect length of total sleep?
12. How does the temperature affect length of total sleep?

Sources of data

There were two groups observed to obtain material for this study: one at Vassar College, Poughkeepsie, New York, and the other at the Castle Kindergarten, Honolulu, T. H.

The Vassar group consisted of 30 children ranging in age from 1 year 10 months to 4 years 9 months, who, with their mothers, were attending the Euthenics Institute from June 26 to July 26, 1928. The parents of the children were mostly college graduates and were of Anglo-Saxon parentage. While the mothers attended college classes on child psychology and home making, the children attended the nursery school. The children returned to the dormitory with their mothers at night and for an hour during the afternoon. In the morning the children had a rest of 45 minutes and in the afternoon they took naps. The majority of the children had rooms alone at night, but occasionally two children were in a room or the child may have slept in his mother's room. Each child slept alone.

After the mother put the child to bed, she recorded the time on a typed record sheet of paper that was hanging in her corridor. A teacher was in charge of each corridor to record the time each child went to sleep. The mother wrote the time of awakening the next morning. Occasionally, a

mother would forget to sign up, thus making a gap in the record necessitating elimination of that day's record from the study. Otherwise, the records are full and accurate.

At the nursery school there were 2 sleeping rooms, one with 8 children and the other with 22. The children slept on canvas beds in rooms which were not especially darkened. Two teachers were in each room to supervise the sleep. The median mean temperature for the period was 73.5° ranging from 66° to 82.5°, and the median average relative humidity was 75, ranging from 56 to 94. The temperature readings were those obtained from the Wappinger Falls Weather Bureau for Poughkeepsie. As this station had no hygrometer, the nearest humidity obtainable was from New York City which is 72 miles from Poughkeepsie. The average relative humidity was obtained from recordings at 8:00 a.m. and at 8:00 p.m. each day.

The Merrill Palmer Performance Tests for Children of Pre-School Age were given to each child by a psychologist. The heights and weights were obtained at approximately the middle of the experiment. The chronological ages used in the records were those obtained at the same time.

The Castle Nursery School and Kindergarten group of Honolulu, consisted of 136 children ranging in ages from 1 year 5 months to 5 years 10 months. The records in the nursery school began September 23 and ended October 25, 1929. The kindergarten records began October 8 and ended November 11, 1929. The nursery school naps were recorded at school. The nursery school night sleep and the kindergarten nap and night sleep were recorded by the parents at their homes. The hours recorded daily varied greatly showing that a great effort for accuracy had been made. Approximately 180 questionnaires a week were sent out; 136 satisfactory questionnaires were returned, many of them complete records for the whole period. These questionnaires are the basis of this section of the study. Before the questionnaires were sent they were explained fully to the parents in a group meeting. Directions were given in English, Chinese, and Japanese. The coöperation obtained from the mothers was more than had been anticipated. They said they were glad to help as they were "anxious to know how long their children should sleep." The mothers who kept these records so faithfully were of varying economic status. The racial group predominating, however, was Oriental. The Oriental cases numbered 96 as opposed to 22 Anglo Saxons, 10 Hawaiian, 5 Portuguese, and 3 Filipino.

The mothers were asked to record the time the child was put to bed, the time the child went to sleep, and the hour at which he awakened both for nap and night sleep. Even if the child did not go to sleep at nap time, record was to be made of this fact. The sleeping conditions of the children varied greatly and for the most part showed great contrast to those of the Vassar group. A majority of the Honolulu group slept in rooms with one or more people. Most of them slept on beds but a few Japanese slept on matting on the floor. The kindergarten children had a 20 minute rest period in the morning and the nursery

school children a rest of 45 minutes. The nursery school children did not go to sleep in the morning but slept in the afternoon. The room was not darkened. The children lay on the floor on mats covered with a sheet and, if needed, a blanket. The median mean temperature for Honolulu during the experiment was 78°, ranging from 74° to 80°, and the median average relative humidity was 72, ranging from 66 to 89.

The height was taken at the beginning of the time, for the nursery school during the week of September 23, and for the kindergarten during the week of October 8. The weight of the nursery school children was taken during the first week (September 23–27) and during the last week (October 21–25) and the average weight for the period calculated. The weight for the kindergarten was taken at the beginning, during the week of October 7–11 and during the last week, November 5–11, and the average weight calculated.

The Goodenough Drawing Test of Intelligence was given to the children over 4 years of age. The test was not given under this age as there is no correlation with the Terman Revision of the Binet below that age. The average correlation between the Binet and the Goodenough for the age 4 years to 10 years is .741 with a P.E. of ±.016. Such a test was considered desirable, as many of the children hear only Oriental languages in the home. By using a performance test such as the Goodenough, the language element was largely eliminated. The tendency to respond negatively to language tests by young children, especially bilinguals, was overcome. The test was given during the last week, November 5–11.

The age of each individual child was calculated from the middle of the period, after which the child was placed in a group from 1 year 0 months to 5 years 12 months in groupings of 6 month intervals.

There were no special methods used to induce sleep except restraint of excess motion when absolutely necessary. The standard set for parents and teachers for recognizing the onset of sleep was the cessation of movement and the continued closure of the eyes

In order to ascertain the influence of relative humidity on total sleep, it was necessary to use the Honolulu group in order to eliminate the influence of varying temperature. This elimination could be done as the temperature was fairly constant, ranging from 74° to 80°. The recordings of relative humidity were divided into low, medium and high groups; the humidity in the low group ranging from 66 to 67.5; in the medium group, from 71 to 80.5; in the high group, from 87.5 to 89. The records of 3 days' relative humidity were placed in each group. The median total sleep for those days was found and compared with the groups of varying relative humidity. After having ascertained the influence of relative humidity, the influence of temperature on the Vassar group was then determined by selecting as samples the records for 3 days each of low, medium and high temperatures. The average for the days of lowest temperature was 69°, for medium 72.3°, and for the highest 78°. The median total sleep for these days was found and compared with the groups having varying

TABLE 1

*Comparison of sleep records of Castle and Vassar nursery schools**

AGE GROUP	NURSERY SCHOOL	NUMBER OF CASES	NAP: Minutes to go to sleep	NAP: Time slept	NIGHT: Minutes to go to sleep	NIGHT: Time slept	TOTAL TIME SLEPT
yrs. mos. yrs. mos.				*min.*		*hrs. min.*	*hrs. min.*
1 0 - 1 6	Castle	2	15	70	5	11 30	12 40
	Vassar						
	Differences						
1 7 - 1 12	Castle	4	25	60	15	11 00	11 50
	Vassar	3	25	00	25	10 55	12 30
	Differences		0	−30	−10	5	−40
2 0 - 2 6	Castle	8	20	75	15	11 00	12 10
	Vassar	6	20	90	30	10 40	11 55
	Differences		0	−15	−15	20	15
2 7 - 2 12	Castle	6	20	75	25	10 10	11 25
	Vassar	4	40	80	75	10 10	11 35
	Differences		−20	−5	−50	0	−10
3 0 - 3 6	Castle	14	45	55	15	11 00	11 30
	Vassar	6	45	80	55	10 10	11 20
	Differences		0	−25	−40	50	10
3 7 - 3 12	Castle	12	30	45	15	10 55	11 35
	Vassar	4	40	65	70	10 00	10 55
	Differences		−10	−20	−55	55	40
4 0 - 4 6	Castle	14	30	50	15	10 45	11 25
	Vassar	5	45	45	35	10 45	11 05
	Differences		−15	5	−20	0	20
4 7 - 4 12	Castle	25	35	45	20	10 45	11 30
	Vassar	2	30	60	65	9 45	10 45
	Differences		5	−15	−45	60	45
5 0 - 5 6	Castle	37	35	40	15	10 50	11 20
	Vassar						
	Differences						
5 7 - 5 12	Castle	14	X	00	15	10 45	11 25
	Vassar						
	Differences						

* The differences were obtained by subtracting Vassar records from Castle records. The minus sign indicates longer time for Vassar group.

temperatures. The experiments in both situations were conducted by the same person, thus insuring uniformity of procedure.

RESULTS

Time required to go to sleep for nap

The time to go to sleep for nap at Castle ranges from 15 minutes to 45 minutes, and at Vassar from 25 minutes to 45 minutes. There is no apparent tendency to increase or decrease with age during the preschool period. There are 4 positive records opposed to 3 negative records. This shows that the median time to go to sleep in the two places is about the same. (Table 1).

minutes longer from 4 year 0 months to 4 years 6 months. In other words, the 6 negative records indicate a longer nap for Vassar than for Castle.

Another tendency with regard to nap is seen in table 2, which is a record of the days the children took rests but did not sleep. The Castle group shows a tendency for the number of naps to decrease as the child gets older. The tendency is for the child of 1 year to sleep every day, the number of naps decreasing fairly regularly until at 5 years 7 months he sleeps 42 per cent of the nap periods.

TABLE 2

*Per cent of days with rest, without sleep Castle kindergarten and nursery school**

AGE GROUP	NUMBER OF CASES	NUMBER OF DAY RECORDINGS (REST AND SLEEP)	NUMBER OF DAY RESTS (WITHOUT SLEEP)	PER CENT OF DAYS WITHOUT SLEEP
yrs. mos. yrs. mos.				
1 0 – 1 6	2	30	00	00
1 7 – 1 12	4	57	12	21
2 0 – 2 6	8	142	6	4
2 7 – 2 12	6	90	4	4
3 0 – 3 6	14	212	88	42
3 7 – 3 12	12	224	93	42
4 0 – 4 6	14	306	162	41
4 7 – 4 12	25	594	254	43
5 0 – 5 6	37	791	368	47
5 7 – 5 12	14	236	136	58

* The number of recordings are the sum of the individual records for each age group, including those with and without sleep. The per cent of days without sleep for each age group was obtained by dividing the days without sleep by the number of recordings for that group.

Length of nap

The length of nap at Castle shows a tendency to reduce irregularly from 75 minutes to 40 minutes and the nap entirely disappears at 5½ years according to the median records. At Vassar the nap ranges from 90 to 45 minutes. With one exception only, the Vassar children had longer naps than the Castle children. The one exception was when the Castle children slept 5 cent of the nap periods.

Time required to go to sleep at night

The time required to go to sleep at night by the Vassar group was longer in each case. The Vassar range is from 25 minutes to 75 minutes and the Castle range is from 5 to 25 minutes. The longer nap at Vassar may have been the cause of the longer time required to go to sleep at night.

The length of night sleep

The length of night sleep at Castle tends to decrease fairly regularly from 11 hours and 30 minutes for the group from 1 year 0 months to 1 year 6 months to 10 hours and 45 minutes for the group 5 years 7 months to 5 years 12 months. The range is from 11 hours and 30 minutes to 10 hours and 10 minutes. The 10 hours and 10 minutes may be caused by the small number of cases in the group. In the Vassar group the decrease is even more regular, the total declining with only one exception. The range is from 10 hours and 55 minutes for the 1 year 7 months to 1 year 12 months group, to 9 hours and 45 minutes for the 4 year 7 months to 4 years 12 months group. The Hawaii group tends to sleep longer at night than the Vassar group.

Median total sleep and comparison of Vassar and Castle

The median total sleep for Castle tends to decrease irregularly from 12 hours and 40 minutes to 11 hours and 20 minutes. The children of the 1 year 0 months to 1 year 6 months group tend to sleep the most. The children from 5 years 0 months slept 11 hours and 20 minutes. At Vassar the range was from 12 hours 30 minutes, for the 1 year 6 months to 1 year 12 months group, to 10 hours and 45 minutes for the 4 year 7 months to 4 years 12 months group. There are only 2 age groups in which the Vassar children had more total sleep than the Castle children; at 1 year 7 months to 1 year 12 months, they had 40 minutes more; and from 2 years 7 months to 2 years 12 months, 10 minutes more. The Castle children slept 15 minutes more between 2 years 0 months and 2 years 6 months; 40 minutes more between 3 years 7 months and 3 years 12 months; 20 minutes more between 4 years 0 months and 4 years 6 months; and 45 minutes between 4 years 7 months and 4 years 12 months.

Correlation between weight and total sleep

The correlation between weight and total sleep is .002 ±.06 which is practically a 0 correlation. By partialling out height and age, the partial correlation is −.11 ±.06 which shows no significant correlation present.

Correlation between nap and night

The correlation between nap and night is −.30 ±.05, a low negative correlation. Partialling out age, this becomes −.44 ±.05 which brings the correlation even lower. Since the correlation between night and age is .103, the negative correlation between nap and night becomes more negative when age is taken out due probably to the shortening of nap at the older ages.

Correlation between total sleep and mental age

The correlation between total sleep and mental age, obtained by partialling out chronological age, is −.33 ± .07. This shows a slight tendency for an inverse relationship between mental age and total sleep for the pre-school children. The mental age of the Castle children approximates the chronological age for those tested. The Vassar children tend to be the superior group mentally insofar as can

be told by the results of tests that are not absolutely comparable. The mental age of the Castle children in chronological group 4 years 0 months to 4 years 6 months was 4 years 6 months; and for the Vassar group, 5 years 8 months; for the Castle children in chronological group 4 years 7 months to 4 years 12 months, the mental age was 5 years 0 months; and for the Vassar group, 6 years 2 months.

Rhythm of total sleep

There seems to be a decided tendency for a long total sleep one day to be followed by a shorter amount the succeeding day. The daily sleep of the child from the 1 year 0 months group varied in the following way: 13 hours 50 minutes one day; 13 hours 15 minutes the next day; 12 hours 35 minutes; 13 hours 20 minutes; 14 hours 15 minutes; 12 hours 50 minutes, etc. This daily rise and fall seems to be characteristic throughout all age groups even in Hawaii where the temperature was fairly constant.

The influence of relative humidity on total sleep

The median total sleep at Castle for October 8, 11, 12, was 11 hours and 30 minutes. The relative humidity ranged from 66 to 67.5 for those days, which were of lowest relative humidity. The median total sleep for October 28, 29, 30, was 11 hours and 20 minutes and the relative humidity ranged from 71 to 80.5, which was the medium humidity. The median total sleep for November 3, 4, 5, was 11 hours and 20 minutes, and the relative humidity ranged from 87.5 to 89, which was the highest humidity. The terms low, medium, and high humidity are relative and refer only to the humidity of Honolulu during this experiment. The median total sleep was 11 hours 30 minutes in the group of lowest humidity, and 11 hours 20 minutes in the next two groups, showing only 10 minutes variation which was probably due to chance rather than to humidity.

The influence of temperature on total sleep

The median total sleep for the Vassar group was 11 hours 35 minutes for the group of records on the 3 days of lowest temperature; 11 hours and 50 minutes on the days of medium temperature; and 11 hours and 25 minutes on the days of highest temperature. The temperature range was 68.5 to 70° on the lowest; 71 to 73.5° on the days of medium temperature; and 75 to 82.5° on the days of highest temperature. The median total sleep was 10 minutes less on the hottest days than on the coolest days, and 25 minutes more on the moderate days than on the hottest days. This shows a slight tendency for longer sleep on cooler days and best sleep on moderate days with a temperature between 71 and 73°. The regularity of temperature in Honolulu may account for longer sleep of the children than at Vassar.

CONCLUSIONS

The median time required to go to sleep at nap does not show any apparent tendency to increase or to decrease with age during the preschool period.

The median length of nap ranges from 40 to 90 minutes.

The frequency of naps decreases fairly regularly. The children slept 100 per cent of the days recorded between 1 year 0 months and 1 year 6 months; and 42 per cent of the days recorded between 5 years 7 months and 5 years 12 months.

The time required to go to sleep at night is from 5 minutes to 75 minutes. The range of the Vassar group was decidedly higher than that of the Castle group. The deferred sleep may have been caused by the longer nap in the afternoon.

The length of median night sleep decreases fairly regularly both in the Vassar and Castle groups from ages 1 year to 6 years. The Castle group tended to sleep longer at night on the whole than the Vassar group.

The median total sleep tends to decrease irregularly both at Castle and at Vassar, the youngest group at Castle, sleeping 12 hours 40 minutes; the oldest group sleeping 11 hours 20 minutes. The Vassar group tended to sleep from 10 to 45 minutes less than the Castle group.

The correlation between sleep at nap and at night would seem to indicate that longer night sleep for the older children is due to a shorter nap.

The correlation between total sleep and mental age shows a slight tendency for an inverse relationship between mental age and total sleep, which may have been a factor in causing shorter sleep for the superior Vassar group.

The rhythm of sleep is indicated by a line that fluctuates daily up and down, showing a tendency for long sleep one day to be followed by short sleep the next.

Relative humidity does not seem to have influenced the amount of total sleep in the study. The median total sleep on the days of highest and lowest humidity both being 11 hours 30 minutes, and on the days of medium relative humidity, 11 hours and 20 minutes.

The influence of temperature on total sleep is slight but shows a tendency for longer sleep on cooler days than on the hottest days with longest sleep on moderate days with a temperature between 71° and 73°. The regularity of temperature may account for the longer sleep of the Honolulu group.

Brief Reports

Infant Responses to Vertical Movements[1]

IN THE course of a study on labyrinthine responses in young infants some interesting observations were made on the effect of dropping infants through a distance of about two feet. Watson (3, 4) held that there are two things even the newborn infant is afraid of and only two. He concludes that the human infant shows fear only in the presence of loud, sharp sounds and when support or balance is suddenly disturbed. He reports that crying is an integral part of the fear pattern.

In a former study the writer (1) reported that when external conditions were kept constant in a continuous day and night study of infants no fear reactions were observed during the first ten days of life.

In regard to the fear pattern in response to loud tones we found in the first study reported in this series that crying never accompanied the presentation of loud tones to twelve infants. The present study presents some data concerning reactions to loss of support.[2]

Infants were raised in the supine position above the head of the experimenter, dropped, and caught after they had fallen through a distance of two feet. Twenty-four infants under one month were used as subjects and given a total of eighty-five trials, about four to each infant. The following tabulation shows that of the

	RESPONSES	PER CENT
Present	75	88
Not present	10	12
Arms alone	35	46
Legs alone	2	3
Arms and legs together	38	51
Extensor-flexion movement in arms	13	
Extensor-flexion movement in legs	28	
Total extensor-flexion movements	41	53
Crying	2	3

eighty-five trials, ten, or 12 per cent, resulted in no overt response, and seventy-five or 88 per cent of the trials resulted in some movement. Of these seventy-five successful responses thirty-five or 46 per cent were confined to the arms alone, two or 3 per cent to the legs alone, and thirty-eight or 51 per cent were response patterns involving both arms and legs. Many of these movements were of a tonic nature possibly suggesting vestibular stimulation. The most definite pattern observed in the arm movements

[1] From Iowa Child Welfare Research Station, State University of Iowa, Iowa City, Iowa.

[2] A pattern analysis by means of the high speed motion picture camera is being made on labyrinthine responses in the Station's infant laboratory.

was a tonic extension with abduction followed by flexion of the arms to the chest (Moro's Umklammerungsreflex, 1918). This pattern occurred in thirteen trials. The same pattern was observed in leg movements in twenty-eight trials. Thus this pattern occurred in 53 per cent of the trials which resulted in movement. The abduction-extensor type of tonus was a characteristic aspect of almost every movement of the limbs. This suggests that these movements may be of a compensatory nature. Further, it is of interest to note that in the total of eighty-five trials only two trials were accompanied by crying.

In order to see if by raising the infant suddenly in the supine position against gravity the response patterns of infants varied from the former situation, twelve infants, two to thirty-three days in age, were used and given forty-five trials, an average of four trials per infant.

The results are indicated below:

	RESPONSES	PER CENT
Present	35	78
Not present	10	22
Total number of trials	45	100
Arms alone	18	51
Legs alone	2	6
Arms and legs together	15	43
Crying	0	0

Ten trials or 22 per cent evoked no responses whatever, and thirty-five trials or 78 per cent resulted in limb movement of some kind. The extensor-flexion pattern is not as prominent as in the first experiment but the tonic extensor effect is still present. Of the thirty-five trials 51 per cent are made by arms alone, 6 per cent by legs alone, and 43 per cent by arms and legs together.

No crying accompanied the forty-five trials.

CONCLUSIONS

The following conclusions may be drawn from this study:

1. When twenty-one infants were dropped eighty-five times, no responses occurred in 12 per cent of the trials, and various patterns of limb movements occurred in 88 per cent of the trials.

2. The most definite pattern was an extensor-flexor pattern which was present in 53 per cent of the successful trials.

3. Of eighty-five trials of loss of support crying occurred only in two instances.

4. When twelve infants were accelerated against gravity forty-five times, no responses occurred in 22 per cent of the trials, and various patterns of limb movements occurred in 78 per cent of the trials.

5. The extensor-flexor pattern was not as striking as under the first set of conditions.

6. Responses showed a tonic character.

7. It is suggested that responses to vertical acceleration may be a compensatory effect.

8. Crying accompanied two trials in a total of 130 trials.

Orvis C. Irwin.

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Food Selections of Nursery School Children*

THE Nursery School meal affords the opportunity for the study of certain food habits of young children. Every nursery school teacher knows that some meals are eaten with relish and are over within twenty or twenty-five minutes while others are drawn out to the limit of the alloted time on the program. It was with a view of determining to what extent there might be preferences for some foods over others in the noon-day menus that we began to record the order in which the children tasted the foods on their plate as well as the order in which they finished them. We are reporting here the observations for the spring and fall quarters of 1929 and the winter and summer quarters of 1930.

There was an enrollment of twenty-four children for all quarters excepting the spring when there were twenty-seven on the roll. The enrollment for the noon-day meal, however, did not exceed fourteen during any quarter since the facilities were insufficient for more than that number. Consequently, the children were divided into two groups. For the first half of the quarter the one group stayed for the meal as well as for the afternoon nap; for the second half, the other group remained.

While as many as from twelve to fourteen children might have been present at any one meal, the attendance usually varied below this maximum. A member of the staff and two graduate students each of whom had had a quarter or two of previous work in the Nursery School served as recorders. A recorder never attempted to observe more than six children. Usually two recorders were available for the noon-day period but occasionally only one; consequently, there were meals when not all the children were observed. Variations

* This investigation was conducted in the Nursery School of the Iowa State College. Much credit is due Miss Marie Harper, a graduate student in the Department of Child Development who assisted in the collection and the classification of the data.

in attendance, changes in location in the dining room on the part of both children and recorders and the availability of recorders were the factors determining the children that were observed. In all, forty-four different children are included in the records. The frequency of observations per child ranges from two to sixty-one, the average being twenty-five.

The typical meal had four foods on the plate: meat or eggs, two vegetables and a sandwich. Milk was served with the main course. Dessert was served only on condition that the plate was cleaned. However, this study is concerned only with the food on the plate.

The record card was a cross-ruled arrangement with the names of the children in the column to the left and the foods served written at the tops of the four double columns. One of the double columns in each case was for recording the order of tasting and the other the order of finishing the particular food. With four foods on the plate, Number 1 was recorded for each child for each food tasted first, 2 for the one tasted second, etc. The same method was used for recording the order of finishing. The values in columns III and IV of table 1 are the averages of these ranks.

The records for the tasting do not represent one-hundred per cent accuracy. On those days when a recorder had a full quota of subjects to observe and when the children were unusually hungry some detail might escape the eye of the recorder. The record for finishing is more reliable. There was some difficulty here however, particularly when a child had the foods on his plate badly mixed.

The results are summarized in the tables.

Table 1 gives the foods arranged in the order of the average rank for finishing. Crisp bacon heads the list with a rank of 1.87 for tasting and 1.46 for finishing as may be seen in columns III and IV. Columns V and VI indicate, to take the first item as an example, that 28 meals were observed when bacon was served with a sum-total of 230 subjects. Buttered kohlrabi brings up the rear. It was observed at only one meal when five children were present. The actual range, on a possible range of three, is 2.54.

Table 2 is a classified summary of table 1. The classification is on the basis of the kind of food as indicated by its name. The numbers in parentheses are the serial numbers of the foods in table 1 which were included in the particular class. It appears from the table that meats, apples, sandwiches, fish and eggs are finished early in the meal while the vegetables are left until the last. With the exception of fish the foods served less frequently tend to remain last on the plate. Conversely, with the exception of potatoes, cabbage and carrots, the foods served most frequently tend to be eaten first. The low rank of potatoes would scarcely have been predicted.

Table 3 is also a classified summary of table 1. Here the classification is on the basis of the mode of preparation. The broiled foods are the preferred meats. Sandwiches and toast may rank high because they are eaten with the fingers rather than with the spoon or fork, which may be a partial explanation of the preferences for raw

TABLE 1

Average rank for tasting and finishing arranged on the basis of finishing

I RANK NUMBER	II NAME OF FOOD	III TASTING RANK	IV FINISHING RANK	V MEALS OBSERVED	VI CHILDREN OBSERVED
1	Bacon, crisp	1.87	1.46	28	230
2	Tomato sandwich	1.86	1.73	3	15
3	Celery sandwich	1.80	1.80	1	5
4	Apple rings	2.43	1.86	1	7
5	Meat balls	1.74	1.91	12	93
6	Liver, broiled	1.67	2.00	1	11
7	Salmon loaf	1.60	2.00	1	5
8	Meat loaf	1.89	2.15	4	28
9	Eggs, goldenrod	2.29	2.16	6	43
10	Peanut butter sandwich	1.83	2.20	14	134
11	Celery cabbage	2.51	2.22	2	23
12	Liver, creamed	2.08	2.24	3	22
13	Apple sandwich	2.43	2.25	19	141
14	Turnips, raw	2.13	2.25	2	20
15	Celery, crisp	2.55	2.27	15	118
16	Bread & butter sandwich	2.30	2.28	52	383
17	Peas, creamed	2.39	2.29	5	38
18	Baked haddock and tomato sauce	1.90	2.29	1	10
19	Lettuce sandwich	2.18	2.30	11	84
20	Tomato, sliced	2.49	2.31	5	30
21	Eggs, creamed	2.34	2.32	5	34
22	Eggs, scrambled	2.55	2.32	30	233
23	Eggs and pea souffle	2.14	2.34	4	36
24	Cabbage sandwiches	2.44	2.34	7	56
25	Carrots, raw	2.36	2.35	5	37
26	Green beans, buttered	2.46	2.39	6	39
27	Eggs, coddled	2.21	2.40	4	42
28	Croutons	2.40	2.40	1	10
29	Celery and cabbage salad	2.50	2.40	1	6
30	Baked haddock and white sauce	2.14	2.40	1	12
31	Eggs, baked	2.28	2.41	5	30
32	Tomato, stewed	2.59	2.42	10	74
33	Toast	2.30	2.47	26	249
34	Liver loaf	2.25	2.50	1	4
35	Pea soup, creamed	2.43	2.52	3	23
36	Potato, scalloped	2.50	2.57	6	56
37	Eggs, poached and spinach	2.19	2.58	3	26
38	Eggs, shirred	2.30	2.58	4	26
39	Bean sprouts	2.00	2.60	2	10
40	Wax beans, creamed	2.50	2.66	1	6
41	Asparagus, creamed	3.73	2.66	1	6
42	Lettuce, crisp	3.11	2.67	23	182
43	Spinach, buttered	2.96	2.67	9	76
44	Cheese, cottage	2.88	2.68	6	61
45	Peas, buttered	2.66	2.69	11	69
46	Eggs, poached	2.14	2.71	1	7

TABLE 1—*Concluded*

I RANK NUMBER	II NAME OF FOOD	III TASTING RANK	IV FINISHING RANK	V MEALS OBSERVED	VI CHILDREN OBSERVED
47	Beet greens	3.50	2.72	1	5
48	Baked haddock	2.80	2.72	3	21
49	Tomato soup	2.57	2.75	8	64
50	Potato, mashed	2.07	2.70	11	78
51	Carrots & celery, creamed	2.97	2.78	3	18
52	Beets, buttered	2.32	2.70	9	66
53	Squash	1.81	2.80	1	5
54	Potato, baked	2.60	2.81	11	80
55	Tomato, scalloped	2.02	2.83	1	12
56	Brussel sprouts	3.67	2.86	1	7
57	Cabbage salad	2.90	2.87	11	78
58	Carrots, buttered	2.87	2.90	5	32
59	Vegetable beef soup	2.49	2.92	8	86
60	Carrots, creamed	3.05	2.04	10	73
61	Peas and carrots, creamed	2.74	2.97	2	22
62	Potato, creamed	3.10	2.99	10	74
63	Green beans, creamed	2.68	3.01	4	23
64	Celery soup, creamed	1.86	3.00	3	34
65	Cabbage & carrot salad	3.24	3.10	4	37
66	Liver casserole	2.60	3.14	6	47
67	Celery, creamed	3.35	3.16	5	30
68	Cauliflower, buttered	2.67	3.10	2	21
69	Kohlrabi salad	3.40	3.20	1	5
70	Macaroni and tomato	2.56	3.21	4	31
71	Carrot & celery salad	3.23	3.23	2	13
72	Peas & carrots, buttered	2.88	3.24	2	16
73	Potato and ham scalloped	2.83	3.31	1	6
74	Spinach soup, creamed	2.67	3.33	1	9
75	Vegetable beef stew	3.33	3.33	1	6
76	Broccoli, buttered	3.42	3.33	2	12
77	Asparagus, creamed on toast	2.40	3.36	1	5
78	Cabbage, creamed	3.01	3.37	5	45
79	Turnips, mashed	3.80	3.40	1	5
80	Tomato aspic jelly on lettuce	3.00	3.40	1	5
81	Cabbage, buttered	3.70	3.40	1	10
82	Onions, creamed	3.26	3.47	5	45
83	Cabbage, raw	3.00	3.50	1	10
84	Turnips, creamed	3.42	3.50	1	12
85	Tomato and rice	3.75	3.50	1	4
86	Kohlrabi, buttered	3.20	4.00	1	5

vegetables over the buttered and the creamed.

In general, the fact that vegetables are found neither in the first six items of table 2 nor the first four of table 3, excepting as occasionally they were served raw in sandwiches, supports the observation of Shelly, (4) Imlay, (1)

TABLE 2

Order of finishing foods according to kind

I CLASS NUMBER	II NAME	III AVERAGE RANK	IV MEALS OBSERVED	V SUBJECTS OBSERVED
1	Meats (1, 5, 6, 8, 12, 34, 66, 73, 75)	1.88	57	447
2	Apples (4, 13)	2.23	20	148
3	Sandwiches (2, 3, 10, 13, 16, 19, 24)	2.25	107	818
4	Fish (7, 18, 30)	2.29	3	27
5	Eggs (9, 21, 22, 23, 27, 31, 37, 38, 46)	2.35	62	469
6	Toast (28, 33)	2.47	27	259
7	Lettuce (19, 42, 80)	2.57	35	271
8	Celery (3, 11, 15, 29, 51, 64, 67, 71)	2.58	32	253
9	Tomatoes (2, 16, 25, 32, 49, 55, 70, 80, 85)	2.60	34	245
10	Peas (17, 23, 35, 45, 61, 72)	2.61	27	204
11	Beans (26, 39, 40, 63)	2.62	13	78
12	Cheese (44)	2.67	6	61
13	Spinach (37, 43, 74)	2.71	13	103
14	Turnips (14, 79, 84)	2.74	4	37
15	Beets (47, 52)	2.79	10	71
16	Squash (53)	2.80	1	5
17	Potatoes (36, 50, 54, 62, 73)	2.81	39	303
18	Cabbage (11, 24, 29, 57, 65, 78, 81, 83)	2.85	32	265
19	Brussel sprouts (56)	2.86	1	7
20	Carrots (25, 51, 58, 60, 61, 66, 71, 72)	2.90	33	248
21	Asparagus (41, 77)	2.98	2	11
22	Cauliflower (68)	3.19	2	11
23	Broccoli (76)	3.33	2	12
24	Onions (82)	3.47	5	45
25	Kohlrabi (69, 86)	3.60	2	10

TABLE 3

Order of finishing foods according to preparation

I CLASS NUMBER	II MODE OF PREPARATION	III AVERAGE RANK	IV MEALS OBSERVED	V SUBJECTS OBSERVED
1	Broiled (1, 5, 6)	1.60	41	334
2	Sandwiches (2, 3, 10, 13, 16, 19, 24)	2.26	107	818
3	Below boiling (22, 27, 44, 46, 80)	2.42	42	348
4	Toast (28, 33)	2.47	27	259
5	Raw (11, 14, 15, 20, 25, 29, 42, 57, 65, 69, 71, 83)	2.60	72	559
6	Boiled (4, 32, 50, 75, 79)	2.61	24	170
7	Baked (7, 8, 18, 30, 31, 34, 36, 38, 48, 53, 54, 55, 73, 85)	2.61	41	308
8	Buttered (26, 39, 43, 45, 47, 52, 56, 68, 72, 76, 78, 82, 86)	2.80	52	308
9	Combinations, cooked (23, 37, 51, 66, 70)	2.86	20	150
10	Soups (35, 49, 59, 64, 74)	2.87	23	216
11	Creamed (9, 12, 17, 21, 40, 41, 51, 60, 61, 62, 63, 67, 77, 78, 82, 84)	2.87	67	503

Thurston (5) and Prentiss (3) as regards the relatively unfavorable reactions of children to vegetables.

The rank of the vegetables with respect to the mode of preparation as indicated in table 3 is at least not inconsistent with the findings of Neely (2) with thirty-six Mexican children enrolled in the Experimental and Demonstration School of the Texas College of Arts and Sciences. She used boiled turnip greens; both raw and boiled turnips, celery and cauliflower; and raw, boiled and pureed carrots and spinach. The vegetables were all served separately in small portions prior to the noonday meal. These vegetables were all quite unfamiliar to this group of children. While the number of servings was too limited to make her findings very significant they were in the direction of a preference for either the raw or the boiled that had retained their form over the soft or the pureed.

It appears in general that the food combinations do not go as well as each item served separately. There were nine combinations of food in which each of the constituents appeared separately so that comparisons may be made between the combinations and each food served alone. Of these combinations, six or 66⅔ per cent had larger averages than either of the elements served separately. Of the three combinations where only one of the elements had been served separately, the averages in every case were higher than for the one taken alone. Apparently we cannot justify the serving of foods in combinations to children on the basis of making the components more palatable. There are of course other reasons for serving foods in combinations not the least of which is that the child will sooner or later find such combinations placed before him and he should learn to eat them not only to make himself socially acceptable but to guarantee a balanced meal.

In every case the children were checked carefully on the time that it took them to clean the plate. The average time that it took the children to finish the main course varied somewhat with the season of the year. Appetite seemed to be the poorest during the months of December, January, June and July, reaching its lowest point in July and its highest in May. The average time for finishing the dinner course in May was practically 16 minutes while in July it was 27 minutes. Correlations of $-.10$ for mental ages on the Merrill-Palmer Scale and time of finishing and of $-.21$ for chronological ages and time of finishing are both insignificant.

A correlation of .79 between order of tasting and order of finishing indicates a general tendency for the children to finish the foods in the same order in which they taste them.

Why the children finish the foods on the plate in the order in which they do is doubtless due to a combination of several factors. It is the writer's opinion that so-called taste preference is the largest single factor which is to be understood to include smell, taste, tactual and temperature qualities, visual appeal, and conditioning as the result of previous emotional reactions in connection with the food. The physical factors are also important.

The mechanical difficulties of eating certain foods are greater than with others. As adults well know, it requires greater skill in getting some foods to the mouth than others, and at least greater endurance in ingesting them once they have arrived.

THOMAS F. VANCE.

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A Preliminary Report on a Study of Fetal Conditioning*

THIS paper is a preliminary report of an attempt to condition a human fetus. The main part of the report concerns the method used for recording the fetal movements. Movements have been recorded (Hicks (2)) by putting a spirograph belt around the mother's abdomen, but this gives a record of the maternal respiration with the fetal movements superimposed and showing merely as irregularities on the respiratory record. We wanted a record which would show the fetal movements only. In order to make such a record we placed a two inch tambour, diaphragm side down, on the mother's abdomen and fastened it there with adhesive tape. The tambour was light enough to ride up and down with the respiratory movements, but heavy enough that the more sudden movements of the abdominal wall due to the kicks of the fetus beneath reacted against the inertia of the tambour and sent a wave up the connecting tubing to a recording tambour. The record was made on smoked paper running on a long paper kymograph. Three such pairs of tambours were used. The attending physician and the writer attempted to place the tambours as follows; one close to the fetus' shoulders, one close to the base of its spine, and the third a little to one side of the latter in a position approximately over the knees. It was necessary to use several tambours because the fetus moves around and because the movements which we attempted to record may have their greatest amplitude in different parts of the fetal body at different times. We considered that a record on any one of the tambours was as good as a

* This work was done incidentally to the writer's general work as a research assistant at Yale University during the Spring of 1931.

record on any other one, and, for the same reason, the height of the excursion of the lever of the recording tambour has no relation to the extensity of the fetal movement.

In order to demonstrate that the movement was truly fetal and not maternal we also took a record of the mother's breathing with a Verdin pneumograph and a pulse record with an Erlanger sphygmomanometer. The one mother whose coöperation we have been able to secure so far breathed so irregularly at all times that the respiratory record is of no value, but at least we can say that no changes in the sphygmomanometer record in conjunction with the fetal movements have been noted. We also gave the mother, who was a para II, a key to press when she felt the fetal kick. The key actuated a signal marker. The maternal record coincided with the fetal record in enough instances to lend weight to the assumption that the tambour records are truly fetal. In some instances, however, the mother recorded movements which did not show on the tambour record or the tambours recorded a movement which the mother did not register. We believe that the records which we have made are truly fetal because: (1) the tambour records coincided temporarily, as far as could be seen, with the movements of the maternal abdominal wall as observed by the physician present and by the writer, (2) because the fetal tambour coincided fairly well with the maternal key record, (3) because no maternal movements were observable through the record of the sphygmomanometer, and (4) because we can think of no part of the mother's anatomy which might produce such movements as a reaction to the stimulus used, a loud sound. I might say that the mother was warned a second or two before the sound each time and that she was so perfectly relaxed that gross, external, 'startle' movements were noted only once out of several dozen applications of the stimuli.

The "native" stimulus used was a loud sound produced by the banging together of two boards by a stout spring taken from a rat trap of the snap variety. The apparatus was fastened to the side of an empty wooden box to increase the intensity of the sound, and placed about two feet to one side of the mother. The stimulus to which the conditioning was to be set up—the "conditioned stimulus"—was a vibration. To produce this we took an ordinary electric bell, removed the gong, bent the striker at right angles to its original position, and soldered shut the make and break contact. The bell was then attached through a transformer to the 110 volt A.C. lighting circuit. When the circuit was closed the A.C. caused the striker to move rapidly up and down. The bell was held by a support in such a position that the clapper pressed against the maternal abdomen somewhere inside the triangle formed by the tambours, not always in the same place.

In use, the vibration was applied for approximately five seconds and then the sound apparatus trigger was released. Both stimuli were recorded by electromagnetic markers on the smoked paper.

One serious difficulty encountered

during the course of the work has not yet been overcome, although it can easily be obviated in the future. Both Forbes and Forbes (1) and Peiper (3) have noticed that after the fetus is stimulated some considerable period of time must elapse before it will again react to the stimulus. After some rather cursory preliminary experimenting we were inclined to doubt this. Later in the course of the work we were again convinced of the existence of this phenomenon, but by this time we had passed the preliminary control period in which the vibratory stimulus had been tested to see if it alone gave the fetal reaction. If a tentative guess may be permitted, it seems that a period of about four minutes after the stimulus is sufficient time for this effect to pass off.

To conclude, we have fairly conclusively demonstrated to ourselves two facts; first, that records can be made of fetal movements, and second, a fact that has already been reported, that an external sound will produce a marked fetal reaction.

The fetus with which the above work was done was born May 3rd, 1931 at the New Haven Hospital, a girl. She has, so far, shown no ill effects from her pre-natal education.

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The Development of Language in Twins

I. A Comparison of Twins and Single Children[1]

Ella J. Day

INTRODUCTION

IN THE year 1886, Horatio Hale (17) in a paper published in the Proceedings of the American Association for the Advancement of Science, reported the case of a pair of twin boys who were so retarded in speech that members of the family could not understand them. These children lived in Boston in 1860. According to the report of an aunt, who visited them frequently, they developed a twin language so unlike English that they could not be sent to school because no one could understand them. Observation of the occasional development of such a special language by twins, suggested the problem of research undertaken here. The twin situation is, from an environmental point of view, quite unlike that of single children and it seemed possible that this might be a factor of considerable significance in the development of language.

[1] From the Institute of Child Welfare, the University of Minnesota. The Development of Language in Twins, Part II, The Development of Twins: Their Resemblances and Differences will appear in a subsequent issue. This will include a discussion of the mental development of twins, and a comparison of the types of twins in intelligence, language development and certain physical traits.

McCarthy's (13) investigation "The Language Development of the Preschool Child" provided an excellent basis for comparison. This study was completed in the summer of 1928 at the Institute of Child Welfare of the University of Minnesota. Dr. McCarthy selected 140 children (20 at each 6 months age level from 18 to 54 months) on the basis of sex and socio-economic status. She visited them and recorded 50 consecutive responses made by each child while he played with a group of toys that she presented to stimulate speech. These data were than analyzed in four different ways: by mean length of response; according to the Piaget functional analysis; by the grammatical construction of the sentence; and a word analysis by parts of speech. In brief the results indicated the developmental changes with age in agreement with other studies, as well as sex differences in favor of the girls. Differences in favor of the upper occupational groups were indicated also in each method of analysis. In the foreword to this study Dr. John E. Anderson says "On the basis of the number of controls utilized in the selecting of subjects and the care and thoroughness with which the data are analyzed, this monograph stands out as one of the best studies

of the development of language which has yet appeared." Thus the present investigation was planned to repeat the McCarthy technique using twins.

PURPOSE

The purpose of this investigation was to compare the development of language in twins with that of singletons of the same ages, sex, and socio-economic status.

2, 3, 4 and 5 years. Since McCarthy reports that 74 per cent of the responses of the 18 months old children were incomprehensible, it seemed adequate from the standpoint of the methods of analysis to be used, to begin with the 2 year age group. The wisdom of carrying the group on through the fifth year was not so apparent at the time the selection was made as the results now show it to be. An equal number

TABLE 1

Distribution of cases by age, sex and occupational class

OCCUPATIONAL CLASS	2 YEARS		3 YEARS		4 YEARS		5 YEARS		ALL (NUMBER OF PAIRS)	TWINS	MINNEAPOLIS POPULATION	MC CARTHY SINGLETONS
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls				
										per cent	*per cent*	*per cent*
I	1	1	2	0	0	2	1	1	4	5.0	5.4	5.0
II	2	0	1	1	0	2	0	2	4	5.0	6.3	6.4
III	7	9	8	8	10	6	9	7	32	40.0	37.9	35.7
IV	6	4	4	6	4	6	3	5	19	23.8	24.3	25.7
V	2	4	3	3	1	5	3	5	13	16.2	14.0	15.7
VI	2	2	2	2	4	0	4	0	8	10.0	11.8	11.4
Total....	20	20	20	20	19	21	20	20	80	100.0	100.0	100.0

SELECTION OF CASES

Through the courtesy of the Minneapolis and St. Paul Departments of Health, the writer had access to the birth registrations. The date of birth, sex, place of birth, name of physician attending the birth and the father's name, address and occupation were all recorded on the registration cards.

Subjects

Age and sex. After consideration of the findings of the McCarthy study, it was decided to select 80 pairs of twins, 20 pairs at each of four age levels, of boys and girls at each age were selected except at age four (see table 1) where there are 19 boys and 21 girls. These age groups are discrete because the records were taken within one month of the birthday. With the exception of one case where the records of the two children were not taken on the same day, the greatest deviation from the birthday was 38 days and the mean deviation for the whole group was 19.69 days. The one exception referred to deviated 99 days from the birthday.

Socio-economic status. The importance of securing a representative

sampling of the population is clearly brought out in such studies as the McCarthy study and the Goodenough (9) evaluation of the Kuhlman-Binet tests for children of pre-school ages. The sampling was made according to the Goodenough (10) classification of the Minneapolis population which was based on the application of the Barr Scale for Occupational Intelligence and the Taussig industrial classification to the 1920 census report of the occupations of males in Minneapolis between the ages of 21 and 45 years. The occupational levels are grouped into a six-fold classification. Group I consists of the professional vocations; group II the managerial occupations; group III the retailers, salesmen and skilled workmen; group IV the semi-skilled workmen; group V the drivers, helpers, etc.; group VI the day laborers. Table 1 shows the percentage of each occupational class found in the Minneapolis population and the percentages represented by the twins and singletons.

The distribution of the sexes is not equal at each occupational class but is equal in the upper three and lower three classes at each age, except at age four.

METHOD OF OBSERVATION

The language record

Just as the selection of cases was made on a basis similar to that used in the McCarthy study, the technique of obtaining the language record was carried out as it was with the singletons. A group of toys consisting of two linenette picture books, one of familiar animals and one of Mother Goose, a very small automobile, a rubber ball, a pasteboard cat that meowed when squeezed, a telephone with a bell, and a small music box were shown to the children to stimulate speech. In so far as possible, McCarthy's toys were duplicated exactly. The examiner requested to see each child alone but this was not always possible. The children were permitted to open the suitcase and look at the toys as they wished. The examiner remained out of the situation as much as possible because spontaneous responses were desired. Some conversations between the examiner and the child however always occurred. When members of the family insisted upon remaining in the room, they sometimes facilitated spontaneous speech on the part of the twin and sometimes interfered with obtaining an accurate record.

Fifty consecutive verbal responses were recorded and the time noted. The responses were recorded exactly as they sounded to the examiner. A response was denoted as complete when a distinct pause occurred. A complete sentence was always considered as a single response, although a single response might be either a complete or incomplete sentence. The mean time for obtaining such a record was 14.9 minutes for the twins as compared with 19.3 minutes for the singletons. The shorter time required by the twins is probably due to two factors. In the first place, they said considerably fewer words in the fifty responses. In the second place, the examiner was in the home anywhere from one to two and a half hours and at least one of the children had a somewhat greater opportunity to become adjusted to the presence of a stranger.

The examiner practiced taking such records with a group of children attending the nursery school at the University of Minnesota, preliminary to taking any records with the twins. She also had the advantage of being able to talk with Dr. McCarthy frequently and so check on minor differences in procedure.

The Intelligence tests

The Goodenough (18) drawing test of intelligence was given by the examiner to all the twins. This test consists merely in having the child draw a man. It is non-verbal and very simple to give. The results however were not useable since such a large percentage of the twins had not manipulated pencil and paper before and therefore they only scribbled.

The department of mental testing of the Institute of Child Welfare volunteered to give the twins the Minnesota Pre-school Scale, (11) which at this time was in the process of standardization. This test was devised by Goodenough and is a revision, for the most part, of the tests for these ages in the Kuhlman-Binet and the Stanford-Binet tests. Test results were obtained on 123 of the 160 children. A full discussion of these results will be presented in Part II.

METHODS OF ANALYSIS

McCarthy's methods of analysis were duplicated exactly. A total of 7,836 responses were made and of these 7,156 or 90 per cent were comprehensible and 780 or 10 per cent were classed as semi-comprehensible or incomprehensible.

Length of response

The comprehensible responses were analyzed first according to length of response. McCarthy set up the following arbitrary rules for this analysis:

(1) Contractions of subject and predicate like "it's" were scored as one word.
(2) Contractions of the verb and negative like "can't" were scored as single words.
(3) Hyphenated words and compound nouns functioning as single words like "Mother Goose" were scored as one word.
(4) Each part of a verbal combination was scored as a separate word.
(5) "Lookit" which occurred frequently was scored as one word if used alone although if followed by an object it counted as two words.

Functional analysis

According to Dewey the primary motive of language is to influence the activity of others. Young children in particular use language as it relates to their needs and give little heed to the adult usage of grammatical constructions and parts of speech. Piaget (16) working at the Institute Rousseau in Geneva developed such a functional classification which with slight revision was used by McCarthy:

A. Egocentric speech
   1. Repetition or echolalia
   2. Monologue
   3. Dual or collective monologue
B. Socialized Speech
   1. Adapted information
      (a) Naming
      (b) Remarks about the immediate situation
      (c) Remarks associated with the situation
      (d) Irrelevant remarks
   2. Criticism

3. Emotionally toned responses
4. Questions
5. Answers
6. Social Phrases
7. Dramatic imitation

Construction analysis

Until one undertakes the analysis of his own speech, or that of other adults, the extent to which adult speech falls short of grammatical standards of construction is scarcely realized. Many of the responses made in adult conversation are not structurally complete sentences, though because of what every adult knows to be implied, they are accepted in good everyday usage. The child patterns after the adults about him since as yet he is neither reading nor writing. For this reason McCarthy first divided the responses into the two groups complete and incomplete but included under the forms of complete sentences a group which were functionally complete but structurally incomplete. The outline of the classification used in this type of analysis is as follows:

A. Complete Responses
   1. Functionally complete but structurally incomplete responses
   2. Simple sentences without a phrase
   3. Simple sentences with a phrase
   4. Compound sentences
   5. Complex sentences
   6. Elaborated sentence, two phrases, two clauses or a clause and a phrase
B. Incomplete Responses
   1. Omission of the verb
   2. Omission of the subject
   3. Omission of a preposition
   4. Omission of a conjunction
   5. Omission of the verb and the subject
   6. Miscellaneous omissions (itemized)

Word analysis

Neither the McCarthy investigation nor the present study are primarily studies of the child's vocabulary. The nature of the experimental situation itself controlled somewhat the words the child used. For instance, by far the largest proportion of nouns used were the names of the toys and pictures shown the child. However, because of the number of children, and their selection, as representative of the Minneapolis population, an analysis of the words, according to the parts of speech, seemed warranted from the standpoint of showing their relative use, in a sample of running conversation.

The rules adopted by McCarthy for determining the number of different words used are similar to those developed by Bateman (1): They are as follows:

1. Include no proper nouns.
2. Include no plural form unless the singular was not used.
3. Include all forms of pronouns.
4. Include no variations of verbs or of adjectives unless they are from a different root.
5. The same word may be listed more than once according to its grammatical use; i.e., if a word is used as a noun and also as a verb, it is included twice.

RELIABILITY

Method of observation

In order to get some estimate of the degree of accuracy in recording such a verbal record, Dr. McCarthy, the examiner, and one other observer took records simultaneously, 25 responses

in length, on 10, two to five year old children, from a settlement house.

Table 2 shows the coefficients of reliability found between each two observers. The examiner first analyzed the language records as to length of response, the functional classification, and the *construction of sentence* category, just as the original data had been treated. The Spearman method of rank differences was used to determine the coefficients of reliability. In length of response the mean for each child according to each observer was used for the correlation and in the other analyses the percentage of whatever item was being correlated was used.

These coefficients seem sufficiently high to indicate reliability of the method of recording.

TABLE 2

Reliability coefficients on the method of recording

	OBSERVERS			
	1 and 2	1 and 3	2 and 3	Mean of all
	p	p	p	p
Mean length of response	.98	.90	.99	.99
Naming	.99	.90	.94	.94
Remarks about immediate situation	.95	.87	.94	.92
Functionally complete but structurally incomplete	.92	.91	.99	.94
Simple sentences	.32	.69	.72	.57
Incomplete sentences	.65	.40	.87	.64

Methods of analysis

The reliability of the various methods of analysis used in treating the language records was not determined in this investigation since McCarthy had determined this and found it to be high.

COMPARISON OF DATA ON LENGTH OF RESPONSE: TWINS AND SINGLETONS CHRONOLOGICAL AGE

The mean length of response is based upon a distribution of the responses, varying in length from one to nineteen words rather than upon a distribution of each child's mean length of response. Figure 1 shows a surprising difference in rate of language development for twins and singletons. At two years the difference is small but appears to become increasingly greater with age and is consistently in favor of the singletons. The mean length of response for the five year old twins is slightly below that of the three year old singletons. A retardation of two years in language development, one would think, was a serious handicap since contacts with our fellowmen depend so largely upon our ability to make ourselves understood verbally.

Critical ratios D/σ_D, computed for each age level were high and increased with age. At two years the ratio was 4.9; at 3, 11.6; and at 4, 15.3. Hence the superiority of singletons to twins in

language development is highly significant statistically.

Smith's investigation (18) of the development of the sentence and the extent of vocabulary in young children agrees very closely with the McCarthy results, and so only further emphasizes the handicap of the twins. The most rapid gain in length of response is made between two and three years by both twins and singletons. Although twins gain only one word in the entire year, singletons gain more than one word in the first half of the year. This difference in rate of development remains relatively the same up to five years. Smith feels that the relatively little gain in length of sentence after four or four and one-half years indicates that the sentence length has little value as a measure of sentence development after this age.

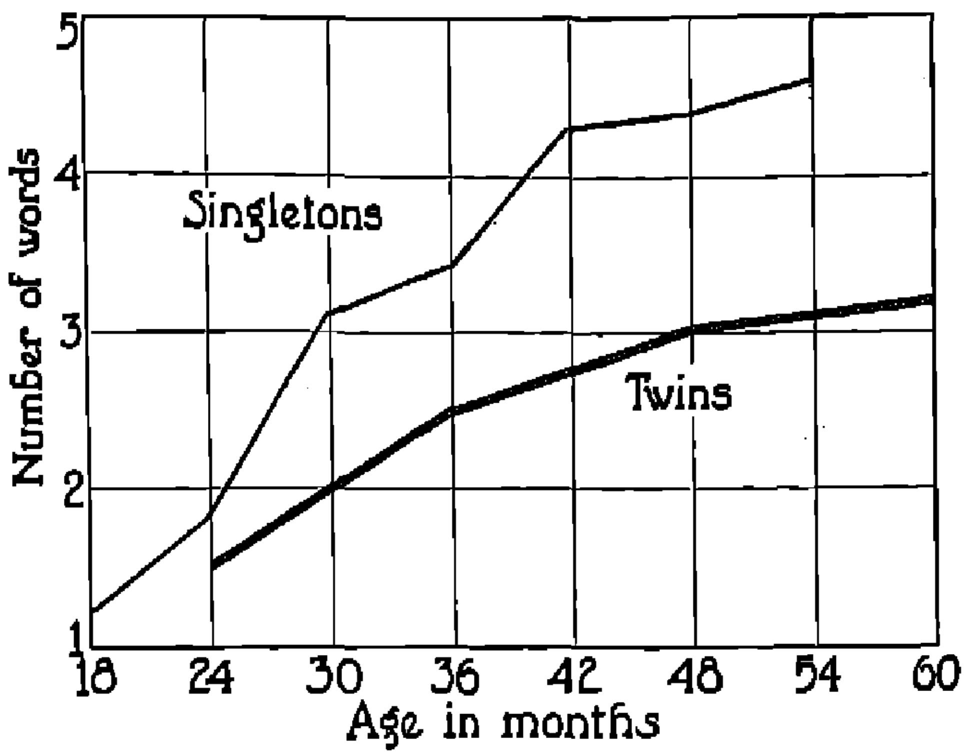

FIG. 1. MEAN LENGTH OF RESPONSE OF SINGLETONS AND TWINS BY CHRONOLOGICAL AGE

The question immediately arises as to when the curve of development for the twins turns and reaches the level of that of the singletons. Does the greater contact with other children, which occurs upon entrance in school, at or soon after the fifth year, stimulate language development sufficiently to give the twins this needed spurt? Does the twin situation so limit the child's environment in the early years of rapid development that he is always at a disadvantage? What is responsible for the retardation, heredity or environment, or both?

All of these questions and many more are as yet unanswered. Nevertheless the author has attempted to get what evidence she could to throw light on the problem.

Part II is devoted to a discussion of the mental ability of the twins but attention may be called at this time to the fact that the mental ability as well

as the language development of the twin group appears to be below average. The mean I. Q. for the whole group is 94. This is based upon the results of the Minnesota Pre-school Scale. The singletons, with whom the twins are compared have a mean I. Q. of 103.3, after the correction recommended by Goodenough has been applied. This correction is a subtraction due to Goodenough's observation that the Kuhlman-Binet test (the test used for the singletons) tended to score too high at the early ages. The singletons then appear to have been a group slightly superior even though they were so carefully selected. Had they been an average group the differences would be slightly decreased. That the twin group deviates even farther from normal is quite true although the evidence seems to be that this is a normal phenomenon rather than a matter of selection.

SEX DIFFERENCES

In agreement with the findings of McCarthy, Nice (15), Gale (6), Mead (14), Terman (20), and Doran (4), this reveals sex differences in favor of the girls. (See figure 2.) These differences are less marked than in the group of singletons at every age except four years, but are consistently in the same direction. It may be noted that at two years the twin girls are slightly superior to the single boys. The twin boys make a greater gain between two and three years than do twin girls but gain less thereafter. The differences between twin boys and girls at five years is greater than at any other age, while the greatest differences between the sexes in singletons was found at

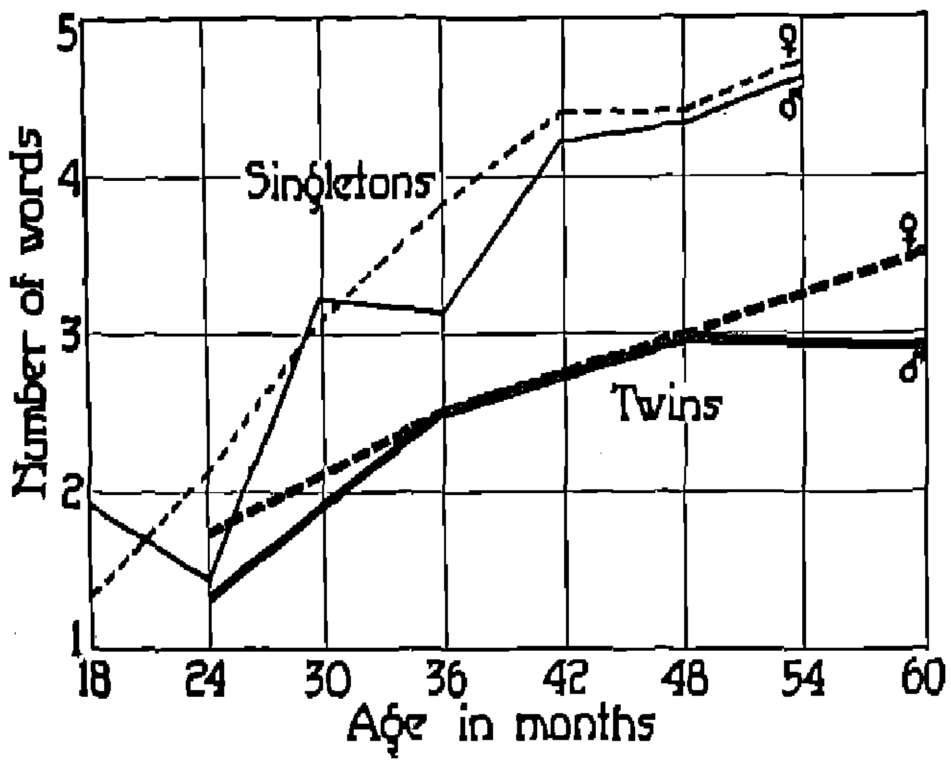

FIG. 2. MEAN LENGTH OF RESPONSE OF SINGLETONS AND TWINS BY SEX AND CHRONOLOGICAL AGE

two and three years. Smith does not report a consistent sex difference.

PATERNAL OCCUPATION

Because of the unequal number of cases in each of the six occupational classes the differences between occupational classes is most fairly shown by dividing the age groups into the upper findings that the age groups become 18, 27, 39 and 51 months, rather than at the exact year levels of the twins. The differences between twins and singletons are even more striking when based upon distribution by occupational class. That the singletons of the lower occupational groups are consistently above the twins of the upper

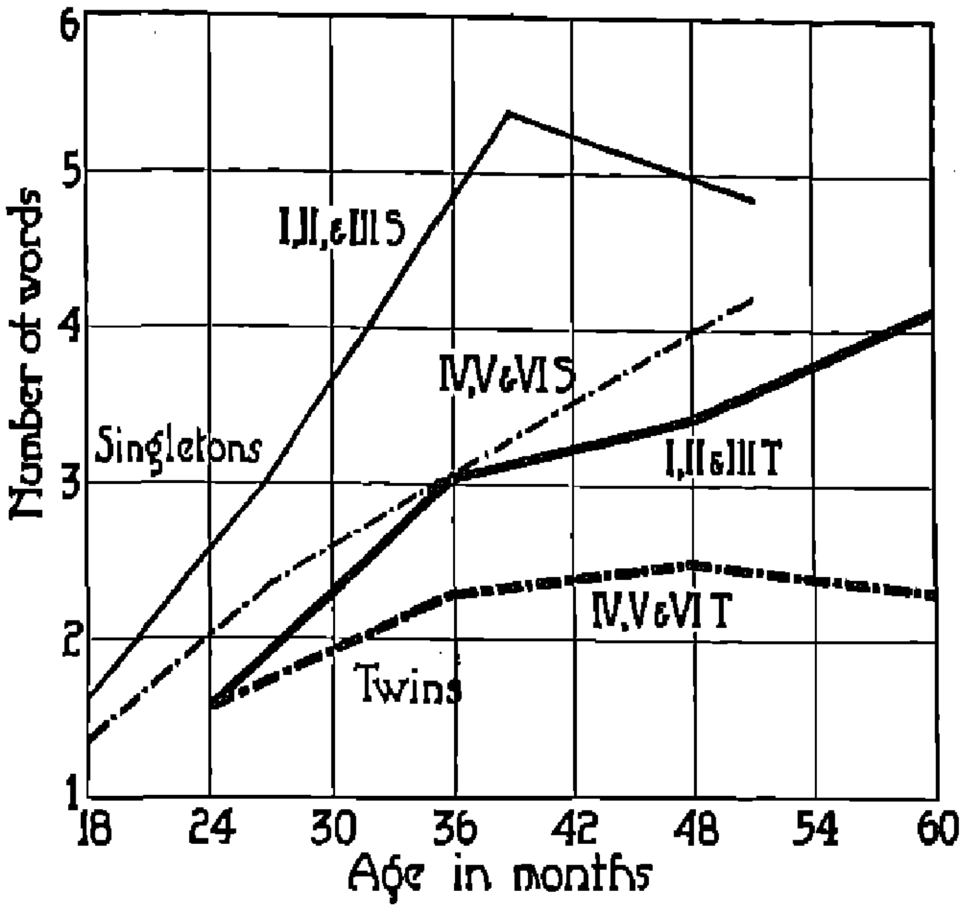

FIG. 3. MEAN LENGTH OF RESPONSE OF SINGLETONS AND TWINS BY UPPER AND LOWER OCCUPATIONAL GROUPS AND CHRONOLOGICAL AGE

three and lower three occupational classes. By so doing an equal number of cases and an equal number of each sex appears in each group. Figure 3 shows the expected differences between these groups. In comparing these results with the McCarthy results it must be noted that the age groups are not strictly comparable. The singletons were so grouped in reporting these groups presents a surprising picture of retardation. The mean of the differences at each age between upper and lower groups is .90 words for the singletons, .85 words for the twins so that the differences between upper and lower groups remain relatively the same. The fanning out of curves of the upper and lower group twins indicates that the difference increases with age, which

suggests that environment plays a rôle in this.

COMPARISON OF DATA ON FUNCTIONAL ANALYSIS; TWINS AND SINGLETONS

The percentage of responses of the functional classification were worked out both inclusive and exclusive of the incomprehensible responses. Figure 4 shows the percentages of this classification based on all responses, including the incomprehensible responses.

When considered from the standpoint of age groups the incomprehensible responses, though somewhat fewer for twins at two years are slightly greater at three and four years and are still in evidence at five years. With the marked retardation in language development indicated by the differences in mean length of response of twins and single children, one might expect a very much greater percentage of incomprehensible responses on the

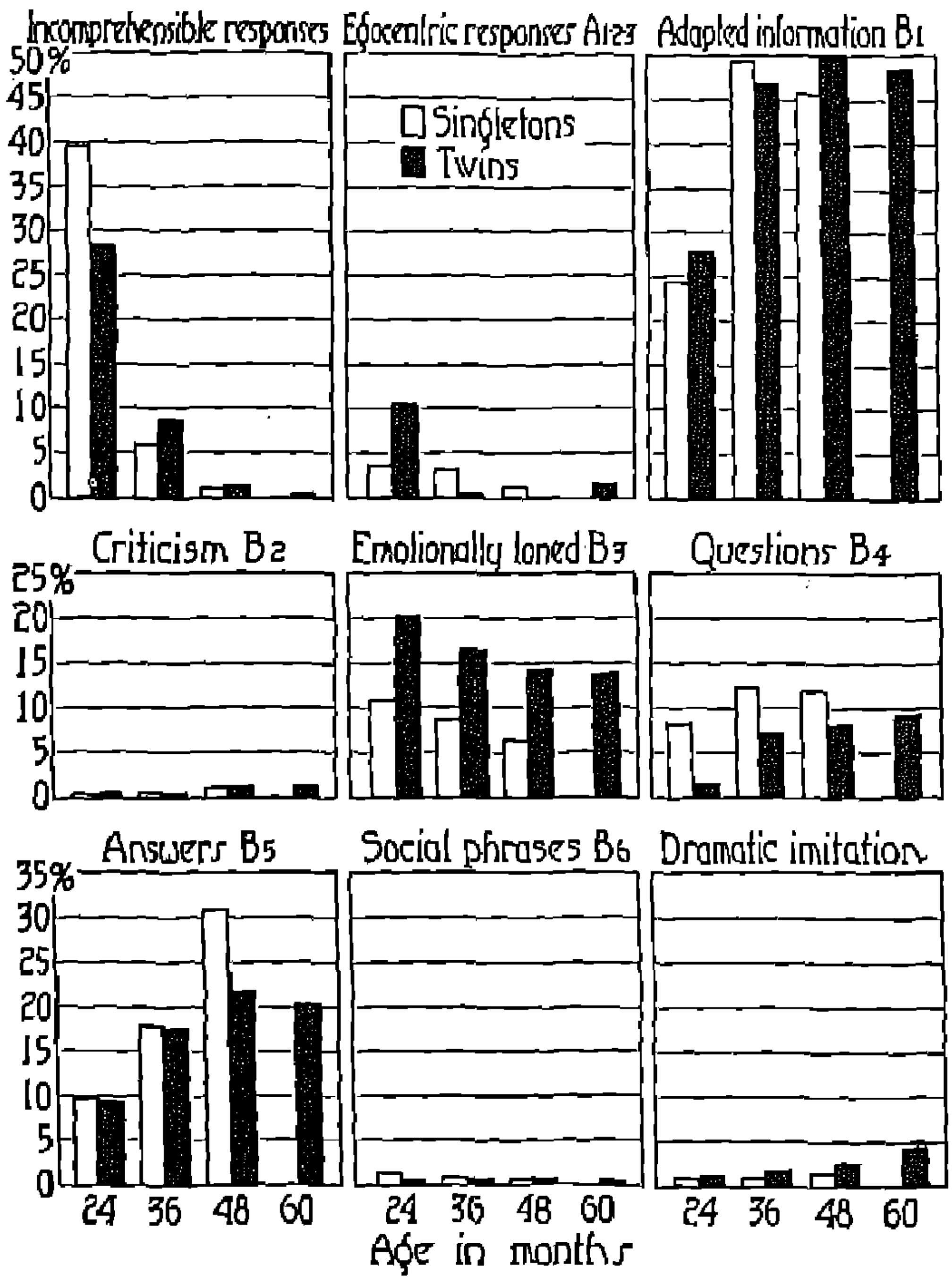

FIG. 4. FUNCTIONAL ANALYSIS OF SINGLETONS AND TWINS BY CHRONOLOGICAL AGE

part of the twin. Such responses do seem to persist for a longer time in the twins, however, which is suggestive of a slower development. Two factors in the twin situation may have acted to reduce somewhat the percentage of incomprehensible responses. It may be easier to understand short statements as compared with long ones and the twin data are composed of many more single word responses. Also, the examiner had had, just previous to making this study, two and one half years nursery school experience and was quite accustomed to interpreting the speech of young children. Dr. McCarthy on the other hand had had only the contact any adult may have with children previous to collecting her data.

The 780 incomprehensible responses include 83 semicomprehensible responses. Of 697 responses actually incomprehensible 287 or 41 per cent were single syllables, 121 or 17 per cent repetition of the same syllable and 289 or 42 per cent a series of different syllables. At two and three years the single syllables slightly exceed the others in number. At four and five years the series of different syllables is in the lead, in fact at five years, it is the only one represented. This type of incomprehensible response is no doubt a poor attempt at adult speech but the single syllables and repetition of the same syllable may be the voice play similar to that practiced by the young infant.

The three types of ego-centric responses described by Piaget are grouped together because each one appears to such a small extent. The twins, though they show more of this type of speech than the singletons at two years, show considerable less at three and four years, with an increase at five years. The twin situation of constant companionship, one might expect, would not be conducive to extensive ego-centric speech but rather to socialized forms of speech.

The different types of socialized speech are best presented in figure 5 where adapted information is divided into its sub-heads of naming, remarks about the immediate situation, remarks associated with the situation, and irrelevant remarks. Here too all percentages appear slightly increased since they are based upon comprehensible responses only.

Though as a whole adapted information shows increase with age and percentages in fairly close agreement with the singletons, when the four types of adapted information are considered separately differences between twins and singletons show up. Naming, the first type scarcely shows any decrease while with the singletons there is a marked decrease. That this function of language, typical of the two year old singletons but not so much so of the four year olds, persists through five years in the twins is indicative of maintenance of early language habits after they should have been dropped.

Remarks about the immediate situation increase with age but are present in greater numbers in twins than in singletons, whereas remarks associated with the situation are very few in number as compared with singletons, show relatively no increase with age, and do not appear at all until three years. In consideration of these two differences, one may wonder whether the limitations of the twin environment may account for these differences.

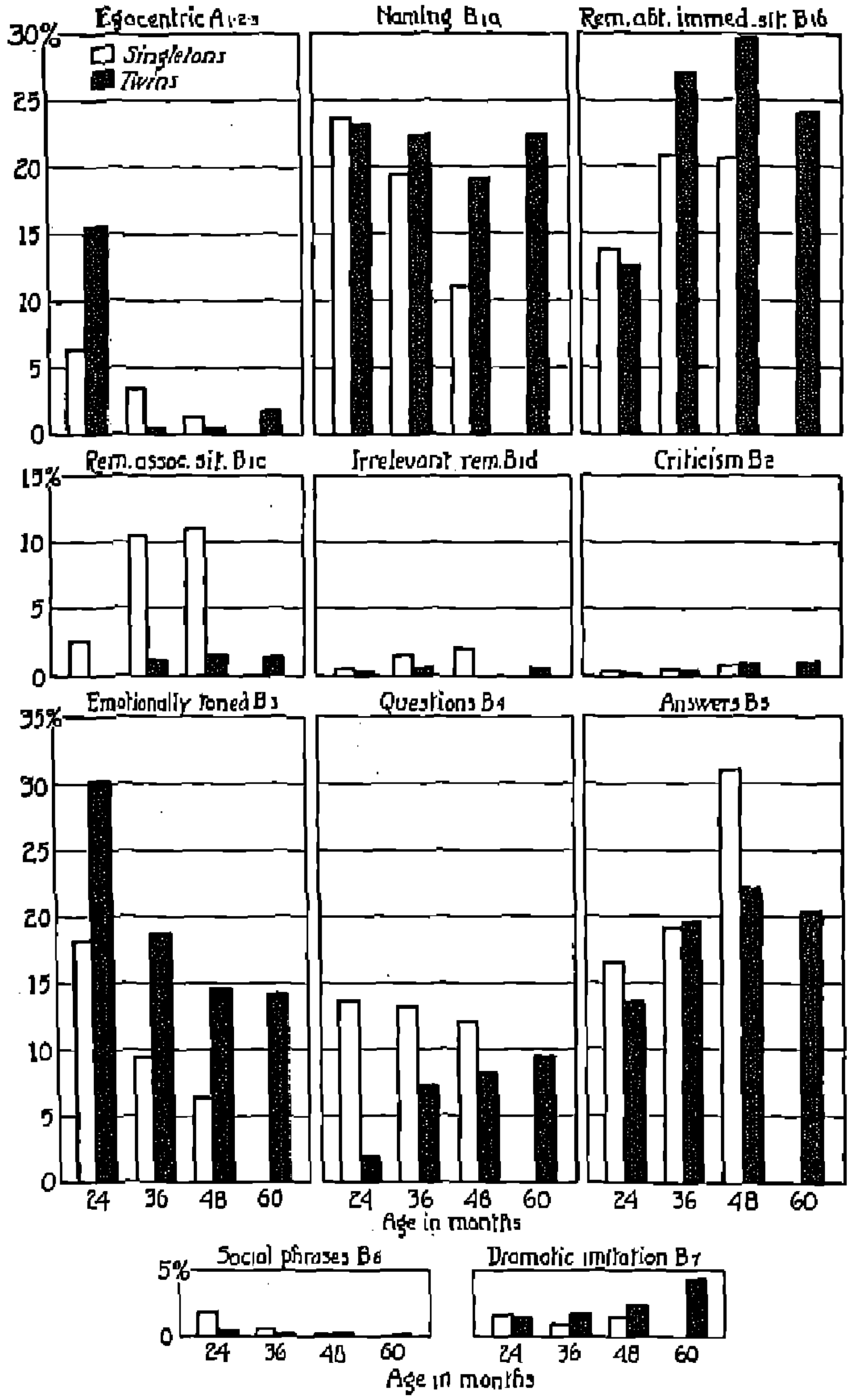

FIG. 5. FUNCTIONAL ANALYSIS OF SINGLETONS AND TWINS BY CHRONOLOGICAL AGE (BASED ON COMPREHENSIBLE RESPONSES)

The percentages of irrelevant remarks are comparatively insignificant. The singletons show a slight increase with age, however, which the twins do not show.

Criticism shows close agreement between twins and singletons and does increase with age.

The emotionally toned responses show one of the most striking differ-

ences between the two groups. Twins have almost double the per cent of the singletons at every age. Both show a decrease with age. This, like naming, is suggestive perhaps of persistence of infantile habits of language.

Questions increase with age in the twins but even at five years have not attained the per cent shown by singletons at two years. This no doubt is somewhat indicative of the retarded language development as well as of a high degree of satisfaction from companionship rather than from investigation of the environment.

Answers also increase with age but neither increase as much nor are present to so great an extent as with single children. This can not be attributed entirely to retarded development, however, since the extent to which the examiner asked the child questions determined to a considerable extent the percentage of answers given.

Social phrases though very much less at two years are slightly less at three years for twins than for singletons and greater at four years. Close companionship may be a factor here in reducing the need for such phrases.

Dramatic imitation increases very much with age and appears to be of greater significance in twins than in singletons. The social advantages of the twins through their companionship may bring this out somewhat more.

In considering the functional analysis as a whole it may be pointed out that the twins show retardation in those phases of the analysis which show the greatest developmental changes with age such as naming, emotionally toned responses, and questions. In ego-centric responses and dramatic imitation, however, they appear in advance of the singletons. These last two phases may easily be the result of close companionship.

As with the singletons, girl twins show some superiority over the boys in those items which make the greatest change with age. Comprehensive tables for these items are too detailed for publication. A large difference between boy and girl twins in incomprehensible responses at two years puts the girls quite inadvance of the boys. At three and four years the girls have a slightly greater percentage of incomprehensible responses, and at five they have less but these differences are so slight and the total percentage at three, four, and five years so small that the reversion is probably due to selection of cases.

The girls also show less ego-centric speech at every age except five years. The differences are small, however, except at two years, which is the most significant age from the standpoint of total percentage of this type of response.

In naming, the boy twins increase slightly while the girls decrease from the second to fourth year and then increase at five years. Girls have somewhat greater proportion of remarks about the situation and both boys and girls increase with age to four years then drop a bit at five years.

Girls increase more and are superior at all ages in remarks associated with the situation.

Emotionally toned responses are decidedly greater for the girls except at age three where a difference of only one per cent is in favor of the boys. The greatest differences in percentage of questions occurs at two years and is in favor of the girls. The other phases

of the functional analysis though they show some differences between the sexes show no striking or consistent trends.

The chief phases of analysis which showed marked differences between the upper three and lower three occupational classes are incomprehensible responses, ego-centric speech, questions, and remarks about the immediate situation. The greatest difference in incomprehensible responses is at two years where the upper class twins show about one-half as great a proportion as the lower class. Just the reverse situation is found in ego-centric speech. The lower group have slightly less than twice as much as the upper group at two years, and have none at all at the other ages. This was also the case with the singletons, except at thirty-nine months, where the lower group exceeded the upper group by quite a large proportion. Perhaps the sampling is not sufficient for these differences to mean a great deal since the percentage at any age is not very great. In both questions and remarks about the immediate situation the differences are not so marked at two and three years but become increasingly so at four and five years. The lower group shows a smaller proportion of these than the upper groups. A similar situation was found with singletons in regard to questions but not in regard to the other phase.

COMPARISON OF DATA ON CONSTRUCTION ANALYSIS: TWINS AND SINGLETONS

Chronological age

Figure 6 again shows that twins are retarded in language development as compared with singletons. Since they were found so retarded when measured by length of response one could scarcely expect to find them using many of the more complex forms of the sentence. It may be said, however, that in general the same tendencies with age are indicated in both the twins and singletons.

The functionally complete and structurally incomplete responses though they decrease with age are present to a somewhat greater extent in twins than in singletons. This group as has been stated, consists very largely of the single word responses. Although such responses appear rather commonly in adult speech they appear there largely in conversational usage while the young children employ them in other ways. For instance, in looking through the picture books it was not uncommon for the children to point at and name objects, and use no sentence at all. Twins evidently maintain this rather infantile manner of talking about what they see longer than do single children.

The simple sentence and all other forms of complete sentences increase with age but at every age are present to a considerably less extent than they are in singletons. The more complex the form of the sentence the greater the relative differences between twins and singletons become.

Incomplete sentences while not always present to a greater extent than in singletons do not drop off as rapidly. This again indicates persistence of early modes of talking or of rather infantile language habits.

The sex differences in sentence structure are not as marked for twins as singletons. There is no consistent

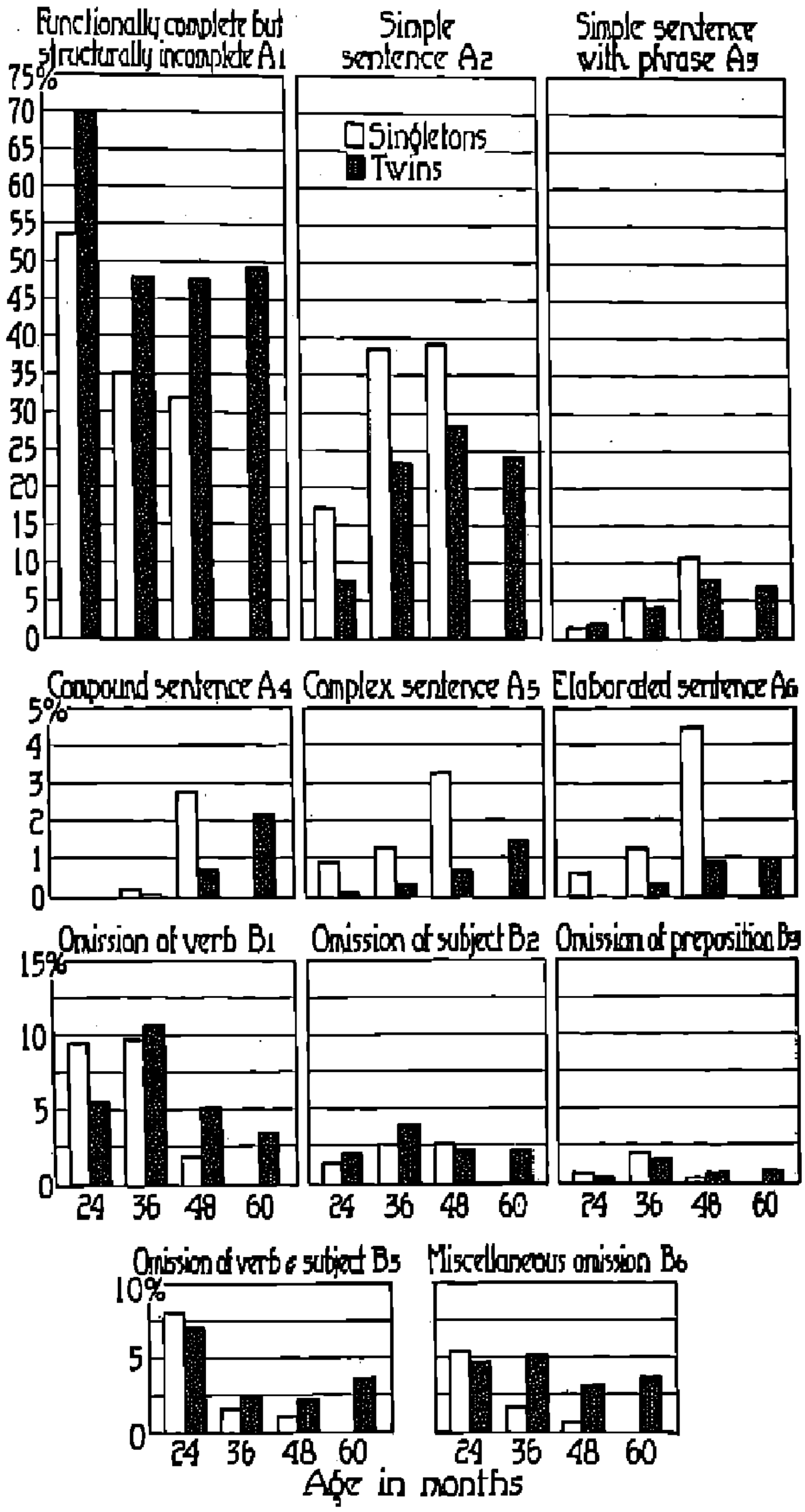

Fig. 6. Construction Analysis of Singletons and Twins by Chronological Age (Exclusive of Incomprehensible Response)

trend in the differences between the boy and the girl twins in any of the items of the classification. It may be noted, however, that the girls do show all the forms of the complete sentence earlier and in larger proportion than the boys. Probably these items show the most important de-

velopmental changes with age and thus the girls may be considered in advance of the boys since they are using the more complex forms of the sentence earlier.

In relation to the singletons both boy and girl twins are retarded. In fact, as in the length of response, the girl twins rank below the boy singletons in practically all classifications of construction. Both sexes show the continuance of the functionally complete but structurally incomplete responses in much greater proportion than do singletons of the same age and sex.

When the responses are considered from the point of view of occupational class and construction of the sentence the differences are again found in favor of the upper groups.

The functionally complete but structurally incomplete responses are maintained in larger proportion through the fifth year by the lower groups and seem to indicate, as has been pointed out before, the continuance of a somewhat infantile habit of speech. All of the more complex forms of the sentence are present to a greater extent in twins from the upper groups than those from the lower groups. But as in the other analyses the upper group of twins is frequently below the lower group of singletons. In the comparison of two groups, however, it must be remembered that the singletons are so grouped that the age falls three months in advance of the age of the twins.

COMPARISON OF WORD ANALYSIS: TWINS AND SINGLETONS

These data were treated in two ways. Both the total number of words used by each child and the number of different words used by each child and each age group, were separated into the parts of speech.

Figure 7 shows the percentage of each part of speech of the total words used. Nouns show close agreement for twins and singletons both in the total percentage used and in the marked drop in percentage from two to three years. The percentage of verbs in which singletons show a gradual increase, from two to four years, is relatively much less at two years in twins, equal to the singletons at three years, and constant thereafter. Adjectives increase from approximately 2 per cent at two years to 8 per cent at five years, in twins. Singletons do not show this marked increase but even at two years have 10 per cent of adjectives, which exceeds the twin five year old percentage. Adverbs, except for a slight use at three years, are constant throughout and slightly greater in percentage in twins than in singletons. Pronouns increase with age to a greater extent in twins than singletons. They are, at every age, somewhat fewer in proportion. Con junctions are late in appearing. Girl singletons show a small per cent at eighteen months and the boys show none until thirty months. A smaller per cent (.9) appears at three years in the twins, and at five years the proportion is still smaller than that for singletons. Prepositions although they show a greater increase with age in twins than in singletons, at two are much less in proportion, the same at four years, and drop some at five years. Although interjections decrease with age markedly, the twins show a very much greater proportion at all ages,

especially at two years, than do singletons. This, no doubt, is related to the large porportion of emotionally toned responses which the twins showed in the functional analysis, and like it, is somewhat indicative of maintenance of infantile language. The miscellaneous parts of speech include words which were difficult to classify more positively, such as "uhm-uh," "uh-uhm" used so frequently for "yes" and "no". These appear to be used to a considerably greater extent by twins than by singletons. This then seems to show a tendency to attain adult standards more slowly.

Table 3 shows the mean number of total words used by both singletons and twins. This shows differences similar to those in the mean length of response. The singletons have but a slight advantage at two years, but show an increasing advantage with age. The 158 words attained by the twins at five years are equaled in number by the singletons between thirty and thirty-six months. The retardation at five years is equivalent to approximately two years.

The percentage of different words of each part of speech used by each age group are presented in figure 8. It may be observed that the changes with age are not the same when considered

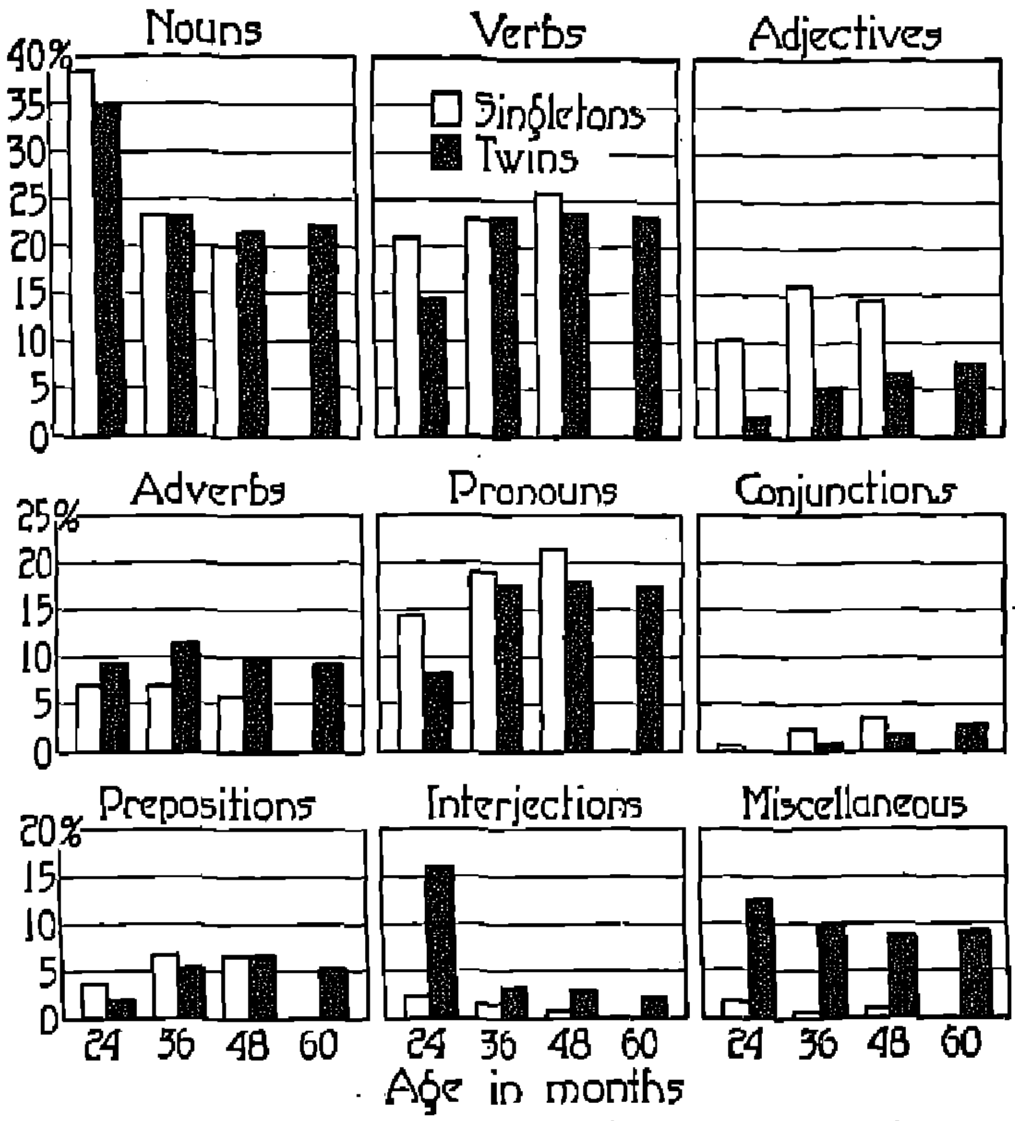

FIG. 7. PERCENTAGE OF PARTS OF SPEECH USED BY CHRONOLOGICAL AGE (BASED ON TOTAL WORDS USED)

from the standpoint of percentage of different words used. For instance, the percentage of nouns remains relatively constant rather than decreasing with age. The child's vocabulary of nouns is actually increasing with age. The percentage of verbs remains relatively constant. Twins show a smaller percentage of verbs than singletons at all ages. Adjectives increase in percentage slightly with age in both groups. The percentage of adverbs

TABLE 3

Mean number of words used by C.A. and sex

CHRONOLOGICAL AGE	MEAN NUMBER OF TOTAL WORDS					
	Singletons (McCarthy)			Twins		
	Boy	Girl	All	Boy	Girl	All
months						
24	36.8	87.1	66.0	40.11	70.9	55.00
36	164.4	176.2	170.3	116.80	112.45	114.63
48	213.4	218.5	216.3	146.31	146.00	146.15
60				143.30	173.20.	158.25

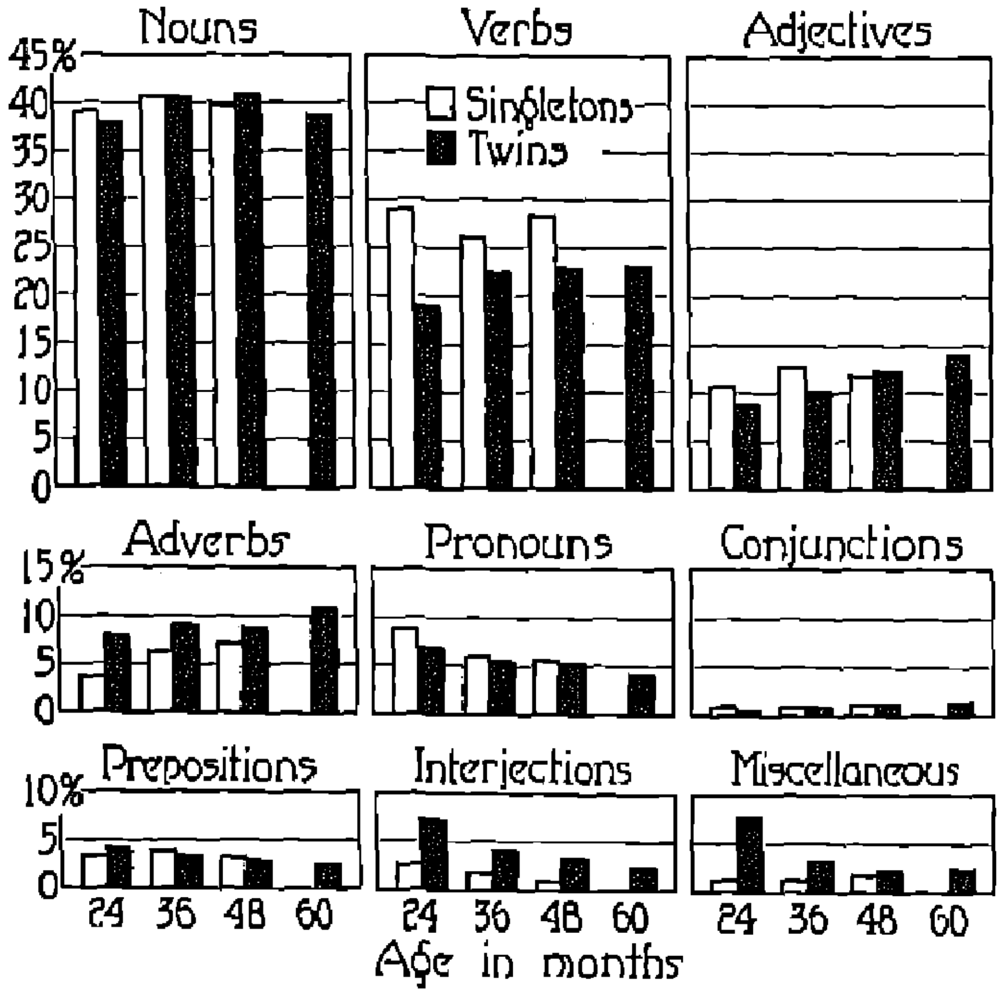

FIG. 8. PERCENTAGE OF PARTS OF SPEECH USED BY CHRONOLOGICAL AGE (BASED ON DIFFERENT WORDS USED AT EACH AGE GROUP)

increases with age more in the singleton group than in the twin group. Pronouns decrease in percentage with age although the actual number after three years remains about constant. Conjunctions increase in percentage a little in both groups and agree closely in total percentages. The percentage of prepositions decreases with age in twins and remains constant in singletons. Interjections decrease in percentage with age. The twins, however, show even at five years, a percentage almost equal to the two year old singleton. The miscellaneous words decrease with age and are higher

Adverbs, interjections and verbs continue to show distinct differences. Twins show a greater percentage of adverbs and interjections and a smaller percentage of verbs.

The sex differences in percentage of parts of speech, of the total words used, are of the same order as in the singleton group although they are less in magnitude in most instances. Girls are in advance. The greatest differences appear at two years, indicating, perhaps the earlier linguistic maturity of the girls.

The total number of words used also favors the girls. As in the mean

TABLE 4

Mean number of different words used by twins and singletons

YEARS	TWINS						SINGLETONS (MC CARTHY)					
	No cases	Boys	No cases	Girls	No cases	All	No cases	Boys	No cases	Girls	No cases	All
2	19	16.4	20	24.2	39	20.4	8	16.6	12	37.3	20	29.1
3	20	45.4	20	45.1	40	45.3	10	60.1	10	66.0	20	62.8
4	19	59.1	21	56.1	40	56.5	9	91.1	11	93.8	20	92.6
5	20	61.3	20	69.4	40	65.3						

in percentage for the twin group than for the singleton group.

The chief differences between singletons and twins in percentage of parts of speech used are in verbs, adjectives, pronouns, conjunctions and interjections. The twins differ from the singletons in showing a smaller percentage of verbs at two years, a smaller percentage of adjectives, pronouns and conjunctions at all ages, and a greater percentage of interjections at all ages. In the percentages of parts of speech of the different words, adjectives, pronouns and conjunctions do not show great differences in proportion between twins and singletons.

length of responses, the boy and girl twins do not differ at three and four years although they show striking differences at two and five years. In the number of different words used (table 4) girls are superior at every age except three years, when the boys exceed by 19 words, the majority of which are verbs.

The twin group when divided into the upper and lower occupational classes shows differences similar to those found in the singletons. The upper group shows a superiority which is most marked at two years in those parts of speech of greatest developmental significance. This may in-

dicate an earlier linguistic maturity of twins from the upper occupational classes.

Descoeudres (2), Drever (5), Gesell and Lord (7), Hertzer and Reindorf (12), Smith and McCarthy all have obtained results which agree in showing a positive relationship between linguistic development and socio-economic status. Stern (19) in reworking the Descoeudres data estimated the difference between educated and working class children to be equivalent to about 8 months in age.

SUMMARY

1. As compared to single children twins are retarded in language development, as measured by each of the methods of analysis used.

2. This language retardation increases with age, within the age period covered (2–5 years) and is most clearly shown in the comparison of the findings of mean length of response.

3. Both in the analysis according to the structure of the sentence, and in the world analysis, twins show the greatest retardation in those phases which make the greatest change with age.

4. This is also true in the functional analysis with the exception of two phases. Ego-centric responses and dramatic imitation, which are both affected, probably by the social advantage of the twin situation, show a superior development in twins as compared with singletons.

5. A small sex difference in favor of the girls appears in all methods of analysis. These sex differences are not as great as in the case of singletons, due possibly to the operation of the social factor.

6. Twins of the upper three occupational classes are superior in all methods of analysis to the twins of the lower three occupational classes.

7. Singletons of the lower three occupational classes are superior in mean length of response to the twins of the upper three occupational classes. They are frequently superior in the phases of the other analyses.

8. The twins in this study were found to be approximately ten points below the I.Q. of the slightly superior group of singletons with whom they were compared.

If in the twin situation each child has the other for a model in speech a large proportion of the time, rather than adults or older children as in the case of singletons, perhaps we may expected slower progress with a poorer model. Nothing in the situation prevents two children from listening simultaneously to what adults say, although the time spent in practicing speech might be limited and considerably reduced. In the first place only one person can talk at a time and in the second place perhaps the activities or even the presence of a twin provide some of the satisfaction otherwise obtained from conversation. Whatever the factors may be however, the evidence is clear that during the preschool years twins progress toward adult use of language at a relatively slow rate.

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Muscular Tension as Related to Physique and Behavior[1]

Elizabeth Duffy

Among the physiological approaches to the study of temperament the measurement of involuntary tensions of the skeletal muscles has seemed especially fruitful on both empirical and theoretical grounds. It appears that studies of tension may be usefully extended in a number of directions. The present paper has as its aim, not the establishment of new facts within this field, but the suggestion of problems for further investigation. To fulfill this function it utilized certain empirical data, limited in extent, yet suggestive of relationships which would merit further study. Many of these relationships, as reported here, could well be due to chance, but where results from a number of different sources appear consistent the likelihood of chance determination is considerably diminished.

[1] We wish to express our appreciation of the assistance given us by the investigators whose names are mentioned in the body of the report and, in addition, to the many members of the staff of the Child Development Institute of Teachers College, Columbia University, who made their records and observations available. This study was conducted while the writer held the position of National Fellow in Child Development.

PROCEDURE

The data to be presented were obtained from a number of observations and measurements in the Child Development Institute of Teachers College, Columbia University. Some of the information was procured from the files of the Institute or was furnished by various members of the staff. Other information was the result of special studies conducted by various investigators who generously made their data available.

The study of muscular tension was made by the writer (3, 4) and has been described in two previous publications. Its essential feature was the measurement of the degree of pressure upon dynamographs held in each hand during discriminative reactions and during tapping. The subjects were 18 nursery school children ranging in age from 2 years, 11 months to 3 years, 10 months (median, 3 years, 3 months). Tension scores, as given in this report, represent the average of the scores from the used and the unused hand on 5 separate occasions when discriminative responses were being made. They are based on the records of 16 subjects, since 2 of the subjects failed to comply with the instructions.

The tapping records were utilized in determining the type of tracing from the point of view of smoothness. The tracings are not sharply divisible into types but may be grouped roughly into three categories: (1) very irregular, (2) moderately irregular, and (3) very smooth. The records of 17 subjects were available for this purpose.

RESULTS

Tension and weight

Of the 16 children for whom we have tension measurements, 5 are within one pound of the average weight for height and age, 6 are above the average in weight, and 5 are below the average in weight. Every one of the 5 children below the average in weight has a tension score above the median, while not a single child with a tension score in the lowest third is below the average in weight. A few children above the average in weight do, however, have high tension scores.

No assumptions need be made here as to the causal relationship between tension and weight. If it should be found, as the result of more extensive investigation, that children who are below the average in weight tend to have high tension scores, two possible explanations would be available. It might be claimed, on the one hand, that undernourished states increase the sensitivity to stimulation, with the result that the impact with the environment produces greater tension in the child who is underweight. It might be claimed, on the other hand, that habits of reaction involving great tension result in depletion of the reserves of the organism and thus reduce the weight. Probably both points of view are correct, and the reaction is of a circular nature, either factor operating as a cause of the other. It is doubtless for this reason that such conditions may become rapidly intensified until they yield only to very thoroughgoing treatment.

Tension and body build

There appears to be a slight relationship between tension and type of body build as measured by the hip width divided by the height. This measure has been used roughly, without regard to the average for the child's age and sex, but the trend of the results is in keeping with that found for weight. The rank order coefficient of correlation between tension and body build is -0.39 ± 0.13. If a line were drawn dividing the children into those above and those below the median for the group in $\frac{\text{hip width}}{\text{height}}$ index it would serve also as a dividing line for those above and those below the median in tension, with but two displacements. The trend indicated is the association of high tension with a slight rather than a heavy body build.

Tension and number of colds

The attendance records of the nursery school indicate that some of the children were at no time during the year absent because of a cold, while other children had as many as four colds during that period. Absences for colds which were not more than a week apart were taken to indicate the con-

tinuation of the original cold rather than the incidence of a new one.

There were 6 children who had at least three or four colds during the school year. Of these 6, three were among the 6 subjects who held the highest ranks in tension, while only 1 was among the 6 who held the lowest ranks in tension. The evidence is far from impressive, but, if colds are frequently the result of fatigue, it would appear likely that individuals ranking high in tension would, in general, be more susceptible to colds, since prolonged states of tension must induce fatigue.

Tension and range of systolic blood pressure and pulse rate

Records of systolic blood pressure and of pulse rate were taken by Miss Frances Baker (1). Measurements were obtained on 3 successive days at four periods of the day: from 8:30 to 9:00 a.m., when the children arrived at school; at 11:00 a.m., after the play period; at about 12:15 p.m., after lunch; and around 2:00 p.m., after the afternoon nap. The range in blood pressure and the range in pulse rate were found in each case by subtracting the lowest from the highest of the twelve measurements.

The Pearson r for tension and range in systolic blood pressure is 0.31 ± 0.14. Expressed in this form, the relationship does not appear close, but it is of interest to note that the 5 children with the highest tension scores are all *above* the median in range of blood pressure, and the 5 children with the lowest tension scores are, with one exception, below the median in range of blood pressure.

Tension and range in pulse rate yield a rank order coefficient of correlation of 0.39 ± 0.14. There were 15 children for whom both tension and pulse measurements were available. Of the 7 who were *above* the median in range of pulse rate, 5 were *above* the median in tension and, conversely, of the 7 who were *below* the median in range of pulse rate, 5 were *below* the median in tension.

The average systolic blood pressure and the average pulse rate in this group bear no relation to tension, but fluctuations in blood pressure and in pulse rate, when measurements are made at different hours and on different days, do appear to be somewhat significant.

Tension and muscular performance

A member of the staff who frequently observed the children during their play period on the roof in order to obtain data upon their muscular activity was asked to make a list of those children who showed great activity and those who tended to be inert. Four were listed in each category. The 4 showing great activity in the play group are all below the median in tension, and 3 of the 4 have tension ranks in the lowest third. The 4 showing least activity in the play group are all above the median in tension and, of these, 3 have tension scores in the highest third.

Ratings on the use of small muscle groups rather than large ones yield similar results. Two out of 3 of the children who use small muscle groups most often have tension scores in the highest third, while both of the children who use large muscle groups

most often have tension scores in the lowest third.

Success in a motor performance was also found to be related to tension. The test in the Merrill-Palmer series which requires the child to trace an irregular figure was given to 10 of these children. Of the 5 who failed it, only 1 was below the median in tension, while 3 of the 5 held ranks 1, 3, and 4 in tension.

General observation supports the conclusion that tense muscles interfere with freedom and ease of motor response and frequently, if not generally, produce awkwardness in the execution of muscular performances.

Tension and physical contacts

Miss Alice Loomis (6) recorded the physical contacts made spontaneously by the nursery school children. A full description of her method has appeared in a recent publication, from which the following is an excerpt: "Each child was observed in 15-minute periods during spontaneous activity when at least four other children were present with opportunity for social interaction, with a total of 2 hours observations on each. . . . . The observations covered 12 weeks . . . ."

There were 13 children for whom there were data on both physical contacts and tension. The rank order coefficient of correlation between tension and total number of physical contacts is -0.54 ± 0.14. The Pearson r for these data, as reported by Loomis, is -0.46 ± 0.15.

Physical contacts were of two types: accidental and intentional. Intentional contacts were defined as "the sum of aggressive and friendly contacts, that is, all physical interactions except the neutral or accidental ones." The rank order coefficient of correlation between tension and intentional contacts is -0.70 ± 0.10, while the Pearson r has been reported to be -0.73 ± 0.09. Loomis concluded that "the descriptive notes in each case confirmed the conclusion that, in this study, children with the highest muscular tension tended to avoid physical contacts though not necessarily social contact, the means being as varied as the individual."

It is of interest to note in this connection that Johnson and Wilson (5), in a study of tension during a tapping performance, reported that "analysis of the behavior of these children in social relations shows that the children with high pressure records had difficulties in adaptation." Duffy (2, 3), in an earlier study of tension, had quoted statements from nursery school records which showed that the children with highest tension were frequently "problem children," and, in a later study, has shown that "individuals with higher tension scores tended to be rated lower on stability and degree of adjustment to the environment." It was shown also that "habituation to a situation tends to decrease tension."

The sensitivity and the difficulties in adjustment in social situations which seem to characterize the "high tension" child undoubtedly deserve further investigation. Miller (7) found, in a study with adults, that, in general, an electric shock caused a smaller arm movement and was reported as less disagreeable with relaxation than without. It seems prob-

able that high tension either produces or is the result of increased sensitivity to stimulation. If this supposition is correct, it would follow that individuals with high tension might frequently react more intensely than other individuals to various types of physical and social contact. Hence, a free and easy relationship with other individuals and with the environment in general would be, for them, more difficult. It may be that from the tensions created by the impact of these individuals with their environment come many of our works of art and our polemics against existing social and economic conditions.

Tension and emotional episodes

Miss Sophie Moissides (8) observed and recorded emotional episodes which occurred during play activity from nine to ten in the morning. She included in her study all instances of laughter or crying which were visible or audible. The total observation period covered 37 hours. Since not all children were observed for an equal period of time she calculated for each child the share in emotional episodes per hour of presence.

These data correlate very negligibly with tension, the rank order coefficient of correlation being 0.24 ± 0.17. The result need not seem surprising, since individuals differ greatly in the degree to which they express emotions overtly. Share per hour in emotional episodes bears a slightly closer relationship to degree of smoothness of the tension tracing. The product moment coefficient of correlation is 0.38 ± 0.14. This aspect of the tension tracing has been held by the writer to indicate degree of inhibition and possibly, of coördination. Five of the children had a very irregular tracing and 5 a very smooth tracing. No one of the 5 with a very smooth tension tracing ranked in the highest third in emotional episodes, and no one of the 5 with a very irregular tension tracing ranked in the lowest third in emotional episodes.

Tension and number of words used

For 15 of the children there was a complete record of all the language used during a period of 12 hours. An analysis of these records provided a count of the words used by each child. The rank order coefficient of correlation between tension and number of words used is $-.37 \pm 0.14$. Four of the 5 children who are highest in tension are in the lowest third for the number of words used, but only 2 of the 5 children lowest in tension are in the highest third for the number of words used. Evidently, there is here a close association between high tension and the use of few words, but not between low tension and the use of many words. The analysis of the speech records may be taken as an index of the extent of the vocabulary, but not of the volume of speech, of the various children.

Tension and behavior during mental testing

During the mental examination the children were in relatively similar situations. It is, therefore, of interest to compare the records of the behavior of the children with the highest tension scores with those of the children with the lowest tension scores. Among the observations on the 4 children with

highest tension scores we find the following remarks:

Subject 1—The rating may be tentative as attention was fleeting throughout.

Subject 2—He appeared completely at ease and happy in the test situation. He was extremely alert, active, and exuberant. There was much extraneous activity. He was constantly shifting his chair and footstool and alternating between a sitting and standing position. He was sensitive to outside noises, such as movements in the hall.

Subject 3—She was very much at ease and happy throughout both test periods. There was spontaneous conversation, both relevant and irrelevant. She worked deliberately and accurately, but not with maximum speed.

Subject 4—He reacted to any imagined difficulty by throwing the test materials on the floor. He always picked them up pleasantly, seemed relieved by his outburst, and went on with the test.

Among the observations on the 4 children with the lowest tension scores we find the following remarks:

Subject 13—He appeared at ease and happy in the test situation. He worked deliberately and steadily.

Subject 14—She worked deliberately and with great care and precision.

She seemed to be the type of child who solves problems by insight, almost never resorting to trial and error methods.

Subject 15—Her interest and persistance were marked throughout.

Subject 16—He adjusted spontaneously to the test situation. Conversation was frequent and relevant.

Three of the 4 children with the highest tension were inattentive, restless, or impulsive, while the 4 children with lowest tension were described as deliberate, persistent, or exceptionally well adjusted to the test situation. For the 4 with the lowest tension there were no remarks to indicate restlessness, emotional outbursts, or distractibility.

SUMMARY AND CONCLUSIONS

The data presented here suggest the possibility of correlations between muscular tension and various physical and physiological factors, such as weight, body build, and range of systolic blood pressure and of pulse rate. Similar correlations are suggested with various aspects of behavior, including muscular performances, number of physical contacts, number of words used, and degree of restlessness and inattention in such a situation as a mental examination.

It seems more than probable that children who habitually manifest a high degree of muscular tension are likely to have special problems which must be recognized and dealt with in a constructive fashion if they are to achieve their ultimate possibilities for poise and for generally well-coördinated behavior. Children of this type seem especially likely to be very sensitive to stimulation of all kinds. This excess sensitivity exposes them to certain dangers. It may lead to insufficiently controlled behavior of various sorts, including stammering, enuresis, impulsive emotional outbursts, and general restlessness. It may, on the other hand, be accompanied by extreme inhibition, leading to with-

drawal or lack of participation in various types of activity. In either event it increases the complexity of social adjustment. Free and easy physical and social contacts are less possible, because responsiveness is so great. The impact of the disagreeable aspects of the environment is felt more keenly, and there is need for guarding against the development of undesirable outlets for the resulting tension. Physical welfare also may suffer from the exhausting effects of too frequent excitement. But the sensitivity and the energy of response which may, under certain circumstances, be such liabilities may, under other circumstances, be valuable assets, contributing to the production of remarkable achievements of various kinds. It seems highly important that research in this field should provide us with more accurate information about the physical and behavior tendencies of the tense child, for with him guidance of reactions becomes of paramount importance.

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The Effect of Unusual Stimulation on Motor Coordination in Children

PAULINE EIGLER

THE ability of children to coördinate their reactions in response to a stimulus pattern that involves one or more unusual stimuli is a problem of learning. A study of the progress in coördination of the movements of the hand which the child can make with visual and electo-tactual stimuli recurring at regular intervals appeared to be of value in finding not only whether the child is or is not able to make the correct responses, but also in giving an analysis of the types of responses made in the attempts to learn such a problem.

In this problem are involved some factors which have been previously investigated in connection with studies on the complication experiment, simple reaction time experiment, synchronic reaction experiment, and problems involving hand-eye coördination. Because of these implications a brief historical survey will be given of this work.

In the latter part of the eighteenth century astronomers were interested in the errors of estimation made by observers. It was found that in the "eye and ear" method of fixing the instant when the star in its transit crossed the reticle of the telescope, individuals varied in their attempts to synchronize the time of the passing of the star with the beat of the clock. The differences in errors of estimation were dependent upon a factor which was termed the "personal equation." Principally from the works of Bessel, Struve, Argelander, Gill, Wolf, and Rogers (30) it was found that the nature of the object observed, its magnitude, its direction and rate of movement, and the illumination of the field were influential upon the estimates; likewise that the position of the observer, his physical condition, the habits set up by the rhythmic recurrence of the stimuli, the knowledge of the amount and direction of the errors, and the direction of attention were all factors that influenced the amount and direction of the error of estimation.

From these investigations on the personal equation there developed a type of experiment dealing with an analogous problem and termed the "complication experiment." The term was devised by Wundt to apply to the study of the temporal relation of a single impression introduced suddenly into a continuous series of impressions. The first experiment made by Wundt was one in which the reactor watched an index-hand traverse a graduated circular dial, while listening to a series of sounds which had the same rhythmic period as the revolutions of the index-hand. The subjects then attempted to judge the position

of the hand coincident with the sound. The purposes of the two types of experiments, the personal equation and the complication reaction, were analogous in that there was to be found the coincidence of the star and the meridian on the one hand, and the synchronization of the index-hand with the sound on the other. In both experiments two types of errors were made: (1) the assumed coincidence which was made prior to the actual coincidence, termed a negative error, and (2) the assumed coincidence was made later than the actual coincidence and called the positive error.

From the early studies which have been reviewed by Burrow (8) and from later studies by Dunlap (9) and Yoakum (39) the following facts were found: (1) Both rate and practice influence the amount and direction of the error; (2) The eye movements occurring with the upward and downward movement of the index-hand had a decided influence on the direction of the error; (3) The type of error made was influenced by the direction of the attention. If the visual stimulus were attended to, there occurred a preponderance of positive errors, while more negative errors occurred when attention was centered on the auditory stimulus; (4) The differences in results when the impressions were presented to one sense or to two senses were practically negligible relative to the type and number of errors; (5) Two general types of judgments were made—"spatial" and "temporal." The "spatial" judgment was that which was made when the subject perceived the spatial position of the discrete stimulus in relation to the alignment; the "temporal" was that which was made when the subject perceived the temporal relation between the two stimuli. This analysis aided in determining the type of errors made under certain conditions; (6) Types of fixation (natural, exact, pointer-pursuit) have been studied and show a direct relation to the amount and direction of the error.

The next phase of the complication problem which was studied was that of rhythmic reactions. In these experiments the subject was required to synchronize a reaction (tapping a key) to a sound or flash which was repeated regularly at several different rates. From the studies of Scripture (31, 32), Johnson (19), Mijake (22), and Dunlap (10), the results were found to be similar to those in the complication experiment. Anticipated and lagged reactions were made to both modes of stimuli. The amount and direction of the error were influenced by the rate of the stimulus and by practice. The direction of attention either to the stimulus or to the reaction had a varying influence on the type of reaction made by different individuals. The reaction to the auditory stimulus was slightly earlier than that made to the visual stimulus. Because of the brief duration of the stimuli accurate synchronization rarely occurred.

The simple reaction time experiment arose in connection with these two problems. A current definition of reaction time is "the period elapsing between the application of a 'stimulus' and the beginning of the 'action' which the stimulus initiates." The work of Cattell (12) and his co-workers and students has shown that

some of the factors and conditions which influence the reaction time are: the sense organ stimulated; the intensity, size, and duration of the stimulus; the length of the fore-period; the type of the reacting movement; *practice, attention, distraction*, and fatigue; incentives, punishment, drugs, and age; and individual differences themselves. The simple reaction differs essentially from the complication and synchronic reactions in that in the latter two the stimuli are recurring rhythmically and several stimulations are to be reacted to. In the simple reaction experiment only "one" reaction is made to "one" stimulus.

The complication and synchronic experiments have been made only with adults as subjects. It was one purpose of the present experiment to see what children of young ages would do in similar situations.

Ability of pre-school children in eye-hand coördinations was studied by Johnson (18), Baldwin and Stecher (3), Wellman (35), and Gesell (13). These investigators used the beat of a metronome as a recurring stimulus. Their results showed age differences. Some found sex differences aside from definite and wide individual variations. Studies of children over six years of age are those of Bryan (6), Whipple (37), Heinlein (15), Bolton (5), Bagley (2), Glenn (14), Wilson (36), and Jones (20). Again, some form of hand movement was to be made in coincidence with a recurring sound. The results for the total accuracy as well as accuracy for each stroke, although not of synchronization, showed age differentiation. Bolton and Bagley found sex differences, and Wilson and Jones found a positive relation between intelligence and the score.

For the studies on adults, aside from those previously discussed, in which synchronization was a factor, those of Bogardus (4) and Perrin (26) are notable. *Both used experimental situations* in which the subject was required to place a one inch cube on a designated one inch square. A block was picked up from a box with the right hand and placed on the square. It was to be removed with the left hand and placed in a funnel by which it was returned to the starting box. The blocks were to be placed at the rate of one a second. A revolving arm (one revolution a second) was so connected that its path lay over the square. If the block were not removed, the revolving arm would hit it. The square was connected electrically so that a record could be made of any displacement of the block (accuracy score). A record of the revolving arm showed the accuracy of synchronization of each placement. Both investigators found wide individual variation and a tendency toward greater inaccuracy with the use of faster rates and longer work periods.

Still another important factor which is involved in the present study is that termed "motivation" and its effect upon "learning." The problem of motivation has been of interest to experimental psychology from a fairly early stage in the development of that science to the present day. From the beginning of interest in this problem, punishment or pain has been one of the favorite modes of studying motivation. Among the forms of punishment adopted, the electric shock has prob-

ably been used more extensively than any other. The electric shock as a motivating factor in any kind of learning or behavior experiment belongs to that type of incentive to which the animal or individual reacts negatively. It has been referred to rather loosely as a "negative motivation."

The study of motivation on humans developed from investigations of animal motivation. For the most part similar problems with similar methods were studied. Electrical stimulation as a motivating factor has been used on humans in studying muscular contractions, reaction time, accuracy of movement, rate of movement, discrimination, and inhibition of response. Miller (21) studied the effect of muscular contraction and relaxation on the non-voluntary response to an electric shock. It was found that during the relaxed condition the extent of the arm movement was decreased; the reaction time of the movement was increased; and the apparent intensity or unpleasantness of the shock was diminished. Johanson (16) studied the influence of an electric shock as punishment upon reaction time. He found that the actual percentage saved in the punishment series as compared with the normal series was 14.8 per cent or 20 sigma. Rexroad (28) investigated the effect of the electric shock on accuracy of reaction to a continuous multiple choice problem. He concluded that the punishment had three effects—disruptive, incentive, and instructive. However, the resultant of the three effects in no case offset the effects from individual differences and daily fluctuations. Bunch (7) investigated the effect of a definite intensity of electric shock on adult human maze learning. She found that there was a 50 per cent reduction in the number of trials; decrease in the number of errors; and 34 per cent decrease in time per trial as a result of the intensity of shock used. Vaughn and Diserens (34) studied the comparative effects of three intensities of electrical punishment on Learning a maze. The experiment showed that light and medium intensities were most efficacious for learning as measured by errors and time. Vaughn's study (33) of the effects of positive and negative instructions in producing inhibitory behavior showed the superiority of the actual punishment (electric shock) over other motives. There were found to be large individual differences, and the children were less influenced than adults. For all the subjects the effects of negative instruction not accompanied by shock wore off rapidly. McTeer (25) investigated the effect of an electric shock as punishment in a ten-unit finger-response multiple-choice serial-order learning problem, and the effect of the shock when applied to the ankle as compared to the effect when applied to the reacting finger. The experiment showed that the punished group learned the problem with fewer trials and fewer errors than the non-punished group. Also, when the intensity was kept constant, the differences in results from differences in application were negligible. McTeer reports two unpublished studies carried out at the University of Wisconsin which investigated the effect of punishment applied to the reacting hand in maze learning as compared to the effect when punishment was applied to the non-reacting hand. One experimenter

found that punishment applied to the reacting hand was more efficacious in the learning problems. The other found practically no significant differences in the results of two groups, one with and one without shock.

PROBLEM AND APPARATUS

The specific problem of the present investigation was to study the ability to learn to synchronize a finger reaction with a recurring flash of light, and to analyze the development of this synchronization.

For this experiment an apparatus was devised so that a study could be be made of the way in which reactions were modified in development of coördination, and the effect of unusual stimuli upon this coördination.

The experiment consisted chiefly of a stimulus (a red light) flashing intermittently at a rate of once every two seconds. The duration of the flash was two-thirds of a second, and the interval between flashes was one and one-third seconds. The response to the stimulus was the depression of a reaction key. If the key were pressed when the light was on, a bell would ring; while, if the key were pressed when the light was off, the bell would not ring. An electric shock circuit was connected so that in parts of the experiment, whenever the key was pressed when the light was not on, a slight shock (.2 milliampere) would be received by the subject. This electro-tactual stimulation caused a slight pricking or tickle effect. A kymographic record was made of both the stimuli and the reactions.

This experiment was somewhat similar to other studies in which rhythmic stimuli were used in that the stimulus was responded to by the depression of a key. However, it differs in that the stimulus was not instantaneous but had a duration. This made it possible for many correct synchronic reactions to be made; whereas in reactions to stimuli of very brief duration, the exact synchronization rarely, if ever, occurs. Also, in previous synchronic experiments, work was done both with and without knowledge of the results, the knowledge being obtained from the scores or from the record after the test trial. In this experiment the ringing of the bell indicated the correctness of the response; the electric shock was also a check on the correctness of the response. Thus for each reaction, the subject knew whether or not the response was accurate.

It was found that the children liked the bell and worked to make it ring. In this way the bell acted as a positive motivation. The shock was disliked and effort was made to react so as to avoid it. In this way the shock served as a negative motivation. The experiments in which the electric shock has been used as a punishment have been those in learning and in reaction times, but the shock has never, to the author's knowledge, been used in experiments with the rhythmic stimulation. It has not been used on such young ages, although the threat of a shock has been used to inhibit movement—Vaughn (62).

The apparatus itself consisted essentially of four main units—the stimulus unit, the reaction unit, the shock unit, and the recording unit. The four units were coördinated, but for explan-

atory purposes they will be taken up separately.

The stimulus unit consisted of a synchronous motor (Dunlap model) which was used to drive four commutators arranged in pairs. The separate commutators for each pair were so constructed that either could be adjusted with respect to the other in order that the relative period during which the commutator brushes were in contact with both members of the pair of commutators could be varied over a relatively wide range. This permitted a variation in the relative amount of time the commutators were closed to the amount of time they were open for any given rate of speed. The absolute rate of the rhythmic stimulation was controlled as follows. On the shaft which carried the bank of commutators were several drive wheels of varying circumferences. The drive belt from the synchronous motor could be looped over any one of these and the speed with which the commutators revolved depended upon the size of the drive wheel used, since the speed of the synchronous motor was constant. One pair of commutators was set so that a circuit was opened and closed causing the light to flash intermittently at the rate and with the duration desired.

The reaction unit consisted of a reaction key, the button of which was insulated by a sheet of bakelite from the remainder of the key. The circuit through one recording pen remained closed, when the key was untouched, and was broken when the key was depressed; this circuit could be made and broken independent of the commutators of the control mechanism. In a second circuit, the stimulus light was connected in a series with one set of commutators. Whenever these commutators were in a position to close this circuit the light would flash. In addition to this a small electric bell was connected in series with the same set of commutators in such a way that the closing of the circuit through the reaction key would cause it to ring. Another factor in the reaction was the possibility of an electric shock. This will be explained in the following section.

Reference may be made for the construction of the electrical unit to Dunlap (21). This consists essentially of a rotary converter which was hooked directly to a D. C. lighting source. The converter thus supplied alternating current which was stepped-up by a transformer from 60 volts to about 2300 volts. This high voltage was passed through resistance which cut down the amperage to a very low and limited range. The actual amperage within a small range could be regulated by a rheostat. The current used was .2 milliampere. It was believed that using a voltage this high would practically eliminate the factor of variation in skin resistance between subjects.

The circuit from the shock-box (indicated in figure 1) was connected with the other pair of the commutators driven by the synchronous motor. From one of this pair of commutators a lead went to the wrist band which was fastened to the reactor's wrist. This wrist band was a thin piece of phosphor-bronze held in place by an elastic band. From the other commutator a lead went to the button of the reaction key. The shock was not used during

all performances of the subject; so when it was not desired, the circuit could be cut out entirely by a hand switch. The wrist band was strapped to the subject's wrist. Contact was made with the button of the key when reacting to the light stimulus. In this way the shock circuit was completed through the body, key, and wrist band. was connected with the pair of commutators which regulated the light stimulus. The other pen was connected with the reaction key circuit in such a way that a mark of the pen was made whenever the key was pressed, regardless of the stimulus. The two pens were set together so that the relation between the occurrence of the stimulus and the reaction could be obtained from the record.

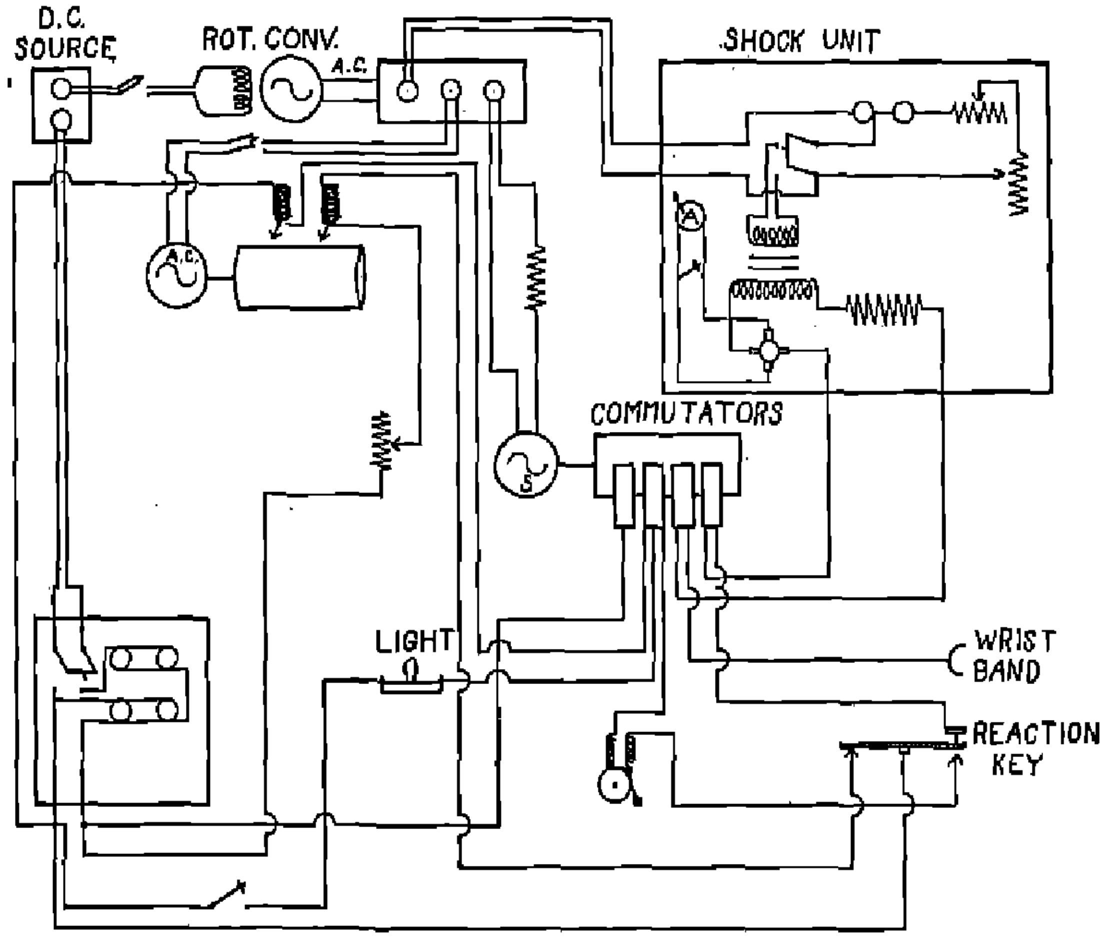

FIG. 1

When both commutators were closed, the shock circuit was shorted through the commutators, and the subject could receive no shock, whether he touched the reaction key or not. If the shock circuit were not closed through the commutators, the current would pass on down to the wrist band and to the button of the reaction key.

The last unit was a continuous paper kymograph device with two electromagnetic activated pens. One pen

For the coördination of these four units, the two pairs of commutators were arranged so that the stimulus circuit would be made and the shock circuit would be shorted simultaneously.

SUBJECTS

Both children and adults were used in the experiment. These may be considered as constituting the two

major groups of subjects. In the main experiment the adult group consisted of 20 persons, 9 men and 11 women. All but 4 of these were graduate students in the Psychology department of the Johns Hopkins University. Another group of 10 adults participated in a preliminary series previous to the final "learning" series. This group included 4 men and 6 women. Nine of these individuals took part in both sections of the experiment.

All of the children who took part in the experiment were members of the Johns Hopkins Child Institute. Three separate series were given with children as subjects. There were 19 children, 13 boys and 6 girls, who took part in the first series; 12 boys in the second series; 22 children, 13 boys and 9 girls in the third series. In the following table (table 1) are shown the age range and the number of children in each age group for the three series. The I. Q. range taken on the Stanford Revision of the Binet scale is also given in this table.

TABLE 1

Chronological grouping of children

First preliminary series

Group I. Chronological age range—1 yr. 11 mos. to 5 yrs. 11 mos. Intelligence quotient range—96–161.

	CHRONOLOGICAL AGE					
	Under 2 years	2–3 years	3–4 years	4–5 years	5–6 years	Total
No.	1	4	6	4	4	19
I. Q.	111	110–161	100–137	96–138	100–137	

Second preliminary series

Group II. Chronological age range—1 yr. 8 mos. to 4 yrs. 10 mos. Intelligence quotient range—107–161.

	CHRONOLOGICAL AGE					
	1–2 years	2–3 years	3–4 years	4–5 years	5–6 years	Total
No.	2	1	6	3	0	12
I. Q.	107–130	161	120–150	112–121		

Learning series

Group III. Chronological age range—2 yrs. 9 mos. to 5 yrs. 10 mos. Intelligence quotient range—89–161.

	CHRONOLOGICAL AGE					
	1–2 years	2–3 years	3–4 years	4–5 years	5–6 years	Total
No.	0	1	14	6	1	22
I. Q.		161	89–150	111–133	121	

PROCEDURE

For adults

For the preliminary tests the rate of the flash was one every second. Forty-five stimuli were given, fifteen of which were without shock and thirty were with shock. The subjects were not instructed concerning the shock until the beginning of the last fifteen of the thirty shock stimuli. At that time they were informed that a shock would be received if the key were pressed at any time when the light was off. The same subjects were given a second trial under the same conditions.

For the "learning" series the subjects were given the following written instructions at the beginning of each trial. "When you look into the black box, you will see a red light flash on and off. If the key is pressed when the light is on, a bell will ring. If the key is pressed when the light is off, the bell will not ring. Your problem is to touch the key quickly every time the light comes on, and make the bell ring. At the signal 'Ready—Go' start tapping the key with each flash of the light. Continue until the signal 'Stop' is given. Be sure to tap the key only while the light is on." Forty-five stimuli were given at a rate of one every two seconds for each trial, 15 of which were without shock and 30 of which were with shock. Ten trials were given. Knowledge of the shock was not given until the beginning of the last 15 of the 30 shock stimuli of the first trial. It was not necessary to repeat this after the first trial. Three individuals were unable to synchronize perfectly at the end of the 10 trials so additional trials were given until one perfect synchronization trial was obtained.

For children

The first preliminary test consisted of two trials. The rate of the flash was one every second and a half. Ten reactions were taken without the shock and twenty with the shock regardless of the number of stimuli required for the number of reactions.

The second preliminary test also consisted of two trials. The rate of the flash was once every second. Forty-five stimuli were presented to which the child was to react. No shock was used for these trials.

For the main test or the "learning" series ten trials were given on separate days. The rate of the flash was one every two seconds, and the duration of the flash was two-thirds of a second. It was found by the preliminary tests that a rate faster than this was too difficult for children of this age. The following instructions were given. "Let us lift up this door. Do you see the red light? Now watch it. It goes off and on, doesn't it? If we touch this button real quickly when the light is on, a bell will ring; like this"—demonstration—"Now you try it. Touch the button whenever the light is on and make the bell ring." Practice was given on touching carefully and quickly. "That's fine. Now let's put the door down; when I lift it up, you be ready to touch the button. When I say 'Go' see if you can touch the button each time the light is on and make the bell ring. Get your finger ready—'Ready—Go'—touch the button every time the light is on." Practice was

given before a record was taken for the first two trials. Forty-five stimuli were given for each trial, 15 of which were without shock and 30 with the shock. The subjects were not told of the shock until 15 stimuli had been given or unless they stopped reacting, in which case they were informed that they would get a "buzz" if they touched the key when the light was off. It was found after two or three trials that twelve children were too "afraid" of the shock to obtain satisfactory results by using it; so, the shock was not used in the remainder of the trials for those children. All other conditions remained the same.

Motivation

The experiment itself proved to be very interesting to the children, but for further motivation each child was given a cord with one colored bead on it at the end of the first trial. After each practice period the child was given one or two beads to string on his cord. All of the cords were kept in the experimental room until the end of the series, then the child was given his string of beads.

RESULTS

Before considering the results obtained in the experiment, it would be well to discuss briefly the nature and characteristics of the graphic records which were obtained of the subjects' performances and from which the quantitative measurements were secured.

By the use of electro-magnetic markers, two separate lines were drawn upon the continuous roll of record paper—a time line and a reaction line. The time line showed a deflection each time the red light flashed on and off, and at the same time gave an indication of the length of time the light was on. The reaction line varied quite independently of the time line and showed a mark each time the reaction key was depressed.

It is quite evident that the reaction marks and the time marks for any single record may stand in any relation to one another. That is, the reaction mark may show that the reaction took place during the time the light was on, or it may show that the reaction occurred at varying intervals before or after the light flashed.

In order to make use of all reactions, whether correct or incorrect, and in order to facilitate handling of the measurements, all reactions which were made were consigned to some one of four separate categories or types of reactions. These four classes of reactions were chosen and named because a predominance of responses seemed to fall into four well-defined groups and the name given to each group is typical of the spatial position of the reaction in that group with respect to the time line.

The first group was termed "synchronizing reactions" or "synchronizations." Only those reactions which were made and completed during the time the light was on were included in this group. Such a reaction can be called a movement which the subject has accurately synchronized with the recurring stimulus or red light.

A second class of possible reactions made by the subjects was the type termed "asynchronizations" or complete misses. In this group fell those

responses which were initiated and terminated during the time the red light was off. This type was a complete miss or error inasmuch as the complete movement took place between flashes and the instructions were to depress the reaction key while the red light was on.

A third type of response was that called "anticipatory reaction" or "anticipation." This type was characterized by the fact that the reaction was commenced and the key was depressed prior to the appearance of the red light, yet the reaction was completed during the flash. In other words, the beginning of the reaction anticipated the light, but a portion of the response was synchronized with the light.

A fourth and final class of responses was that in which the reaction of the subject was initiated during the period the light was on and the first part of the movement was accordingly synchronized with the stimulus, but the subject failed to complete the reaction by the time the light was extinguished. This type of reaction was designated as a "lagging reaction" or "lag" indicating that the subject delayed the final portion of his reaction.

These four types of reactions are illustrated in figure 2.

It must be mentioned that these types of movement are only characteristic of the great majority of responses. However, in some cases responses occurred which were difficult to consign to any one category. For example, a child may have kept the key depressed for a time during which any number of stimuli were presented. Such reactions did occur at times and were handled as best they could be. Another factor to be considered in the types of reactions made was the fact that quite often, especially among the younger children, the subject failed to react at all. These failures to react appeared in numbers sufficient to warrant their consideration and account will be taken of them in the results obtained.

In the discussion of the curves and tables which embody the results, the criterion of learning is taken as an increase in the number of correct responses made during the final trials

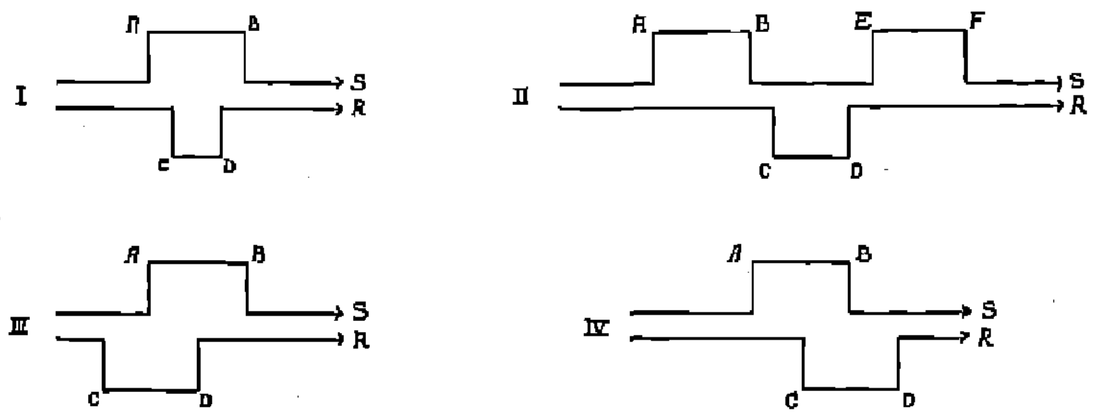

FIG. 2. TYPES OF RESPONSE

S indicates stimulus line, R indicates reaction line. AB represents the duration of the flash of light. CD represents the duration of the complete reaction. I indicates synchronized reaction; II, asynchronized reaction; III, anticipated reaction; and IV, lagged reaction.

in the series as against the number of correct responses made on the first few trials. Correct responses are those which have been classified as perfect "synchronizations" in the above discussion of types of reactions. In the curves which follow, if the line indicating the number of synchronizations shows a marked rise in level, this is taken as an indication of learning. Although this criterion of learning depends essentially upon the trend of the synchronization curve, nevertheless it is apparent that any quantitative change in the other types of reactions may throw considerable light upon the process of acquiring the correct response. The elimination of the incorrect movements is equally important in the learning process, and if it can be demonstrated that throughout the series of trials, the number of incorrect responses diminishes as the number of correct responses increases, then there is no hesitation in asserting that learning has taken place.

In the learning series the total group of children was handled throughout the experiment as a single group. Very soon after the beginning of the investigation it was noticed that the results given by the older children were characteristically different from those given by the younger children. As indicated earlier in this article, the age range of the children was from two to six years, and it is not startling that within a range this great, differing types of results were obtained. The differences between the two groups could be observed in their interest in the situation, in the difficulty with which their attention was held, and in their abilities in motor coördination. As a result of this differentiation, the number of children was considered as two separate sub-groups. But another complication appeared very soon after the introduction of the electric shock into the experimental situation. Some children of both the younger and the older groups tended to become "emotionally upset" as soon as this element was involved. Furthermore, instead of growing accustomed to the shock, some of these children grew more and more "afraid" and more difficult to handle. This antagonism to the shock continued in spite of the fact that the shock was relatively light and so arranged that it could not possibly injure the children. Accordingly, after the third or fourth trial, the shock was discontinued for those children who appeared to be too much disturbed by it. As stated previously, some of these children were members of the older group and some belonged in the younger group. The group of children was therefore divided into four sub-groups, as follows: (1) older children on whom the shock was used throughout; (2) older children with the shock removed after the initial trials; (3) younger children on whom the shock was used throughout; and (4) younger children with the shock removed after the initial trials. The older group with shock used throughout consisted of 6 boys and the older group tested without the shock consisted of 5 children, 4 girls and 1 boy. Of the younger group only 4 boys made up the group receiving the shock throughout and 7 children, 5 girls and 2 boys fell into the group which was tested throughout without the shock. A discussion of

the results of each group taken separately follows.

RESULTS OF THE GROUPS RECEIVING SHOCK THROUGHOUT THE TEN TRIALS

Younger group

In table 2 the average number of each type of response is given for each 15 stimuli presented in the first, fifth, and tenth trials. It may be noted from this table that there is an increase in the average number of synchronizations made, and a decrease in the average number of errors, the greatest reduction being in the number omitted and the next in the number anticipated. The anticipations and omissions occurred most frequently in the first trial and the lag error most frequently in the tenth trial. There were approximately four times as many correct responses made on the tenth trial as were made on the first.

In figure 3 is illustrated the proportion of the types of responses made on each trial for the ten trials. The rise in the level of the columns representing the number of synchronizations is apparent. It may also be noted that from the second trial on, the lag type of error is the predominant type of error made. For the first five trials all types of reactions were made with no one type definitely predominating, yet with a slight decrease in the number of of asynchronization and omission errors which are considered the most erroneous responses in that in neither one is any part of the reaction synchronized with the stimulus. From the sixth trial on, the synchronization type of response definitely predominates.

Learning is indicated from these facts. The process appeared to be first that all types of responses were made; second, the most erroneous responses decreased in number first; third, the partially synchronized reactions next decreased in number; fourth, a slow and then a rapid increase in the number of synchronizations was made.

TABLE 2

TYPES OF RESPONSE	TRIAL I				TRIAL V				TRIAL X			
	1	2	3	T.	1	2	3	T.	1	2	3	T.
A	3.5	0.7	0.0	4.2	3.6	3.5	3.2	10.6	7.0	7.0	6.2	20.2
B	5.0	5.5	2.5	13.0	2.7	2.5	3.5	8.7	1.7	3.0	1.7	7.4
C	4.2	2.0	3.4	9.4	5.7	2.5	2.7	11.0	4.2	1.7	3.7	9.7
D	3.5	1.5	1.5	6.5	3.5	2.0	3.0	8.5	1.7	1.5	2.5	5.7
E	0.5	5.2	6.3	12.0	0.2	4.0	3.5	8.3	1.2	2.2	1.2	4.7

Average number of each type of response for trials I, V, and X for the younger group with shock used throughout. The *vertical columns numbered* 1 *represent the response to the* first 15 stimuli presented without shock; columns numbered 2, to the second 15 stimuli accompanied by shock; columns numbered 3, to the third 15 stimuli accompanied by shock; and columns lettered T, to the total of 45 stimuli. Row A represents the average number of synchronizations; row B, anticipations; row C, lags; row D, asynchronizations; row E, omissions.

Older group

The average number of each type of response for trials one, five, and ten is given in table 3. Again the number of synchronizations increases. Each child made about twice as many correct responses on the tenth trial as he did on the first. The number of asynchronizations and omissions decreased decidedly. For this group the number of anticipation and lag errors was approximately the same at the end of the series.

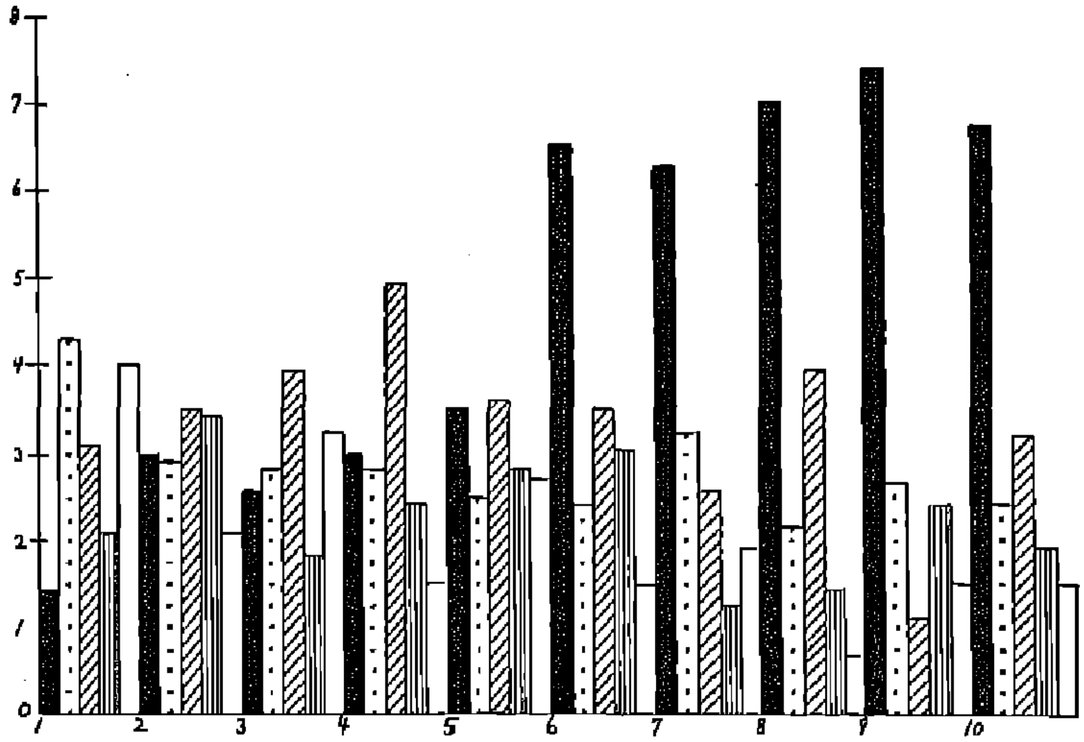

FIG. 3. YOUNGER GROUP, SHOCK USED THROUGHOUT

A group histograph in which are illustrated the types of responses on each trial for 10 trials. The successive trials are given on the abscissa; the average number of responses to 15 stimuli for the group is indicated on the ordinate. The solid column represents the synchronizations made; the dotted column, the number of anticipations; the oblique-line column, the number of lags; the vertical line column, the number of asynchronizations; and the blank column, the number of omissions.

TABLE 3

TYPES OF RESPONSE	TRIAL I				TRIAL V				TRIAL X			
	1	2	3	T.	1	2	3	T.	1	2	3	T.
A	4.5	4.6	4.3	13.5	7.5	5.1	6.5	19.1	9.3	9.0	7.8	26.1
B	1.2	2.1	1.3	4.5	1.5	1.6	0.8	3.9	2.3	2.5	2.1	6.9
C	3.3	2.5	1.6	7.5	3.5	4.0	4.8	12.3	1.0	1.6	2.6	6.0
D	2.6	4.0	3.6	10.3	1.0	1.0	1.8	3.8	0.0	0.1	0.6	0.8
E	3.8	2.1	3.8	9.8	1.5	3.1	2.5	7.1	1.5	1.5	1.8	4.8

Average number of each type of response for trials I, V, and X for the older group with shock used throughout. The vertical columns numbered 1 represent the response to the first 15 stimuli presented without shock; columns numbered 2, to the second 15 stimuli accompanied by shock; columns numbered 3, to the third 15 stimuli accompanied by shock; and columns lettered T, to the total of 45 stimuli. Row A represents the average number of synchronizations; row B, anticipations; row C, lags; row D, asynchronizations; row E, omissions.

Figure 4 illustrates the proportions of the types of responses made in each trial. The steady rises in the level of the black columns representing the number of synchronizations may be noted; also, the corresponding decrease in the number of errors. For the first three trials no one type of response appears predominately. In the fourth and fifth trials differentiation occurs in which the synchronized and lag responses predominate. From the sixth trial on further differentiation occurs in which the synchronized is definitely the predominant type. The omissions and asynchronizations are practically eliminated by the end of the series.

The same steps in the learning process seem to occur for this group as for the younger.

Adults

In table 4 are given the average number of each type of response to each 15 stimuli for the first, fifth, and tenth trials. Although the number of synchronizations on the first trial is large, yet there is an increase, and there is a decrease in all the types of errors. No omissions were made by this group. The lag type of error was the principal type of error, and it shows a marked reduction. The most erroneous reactions were made infrequently by this group; while there were quite a number of partially synchronized reactions.

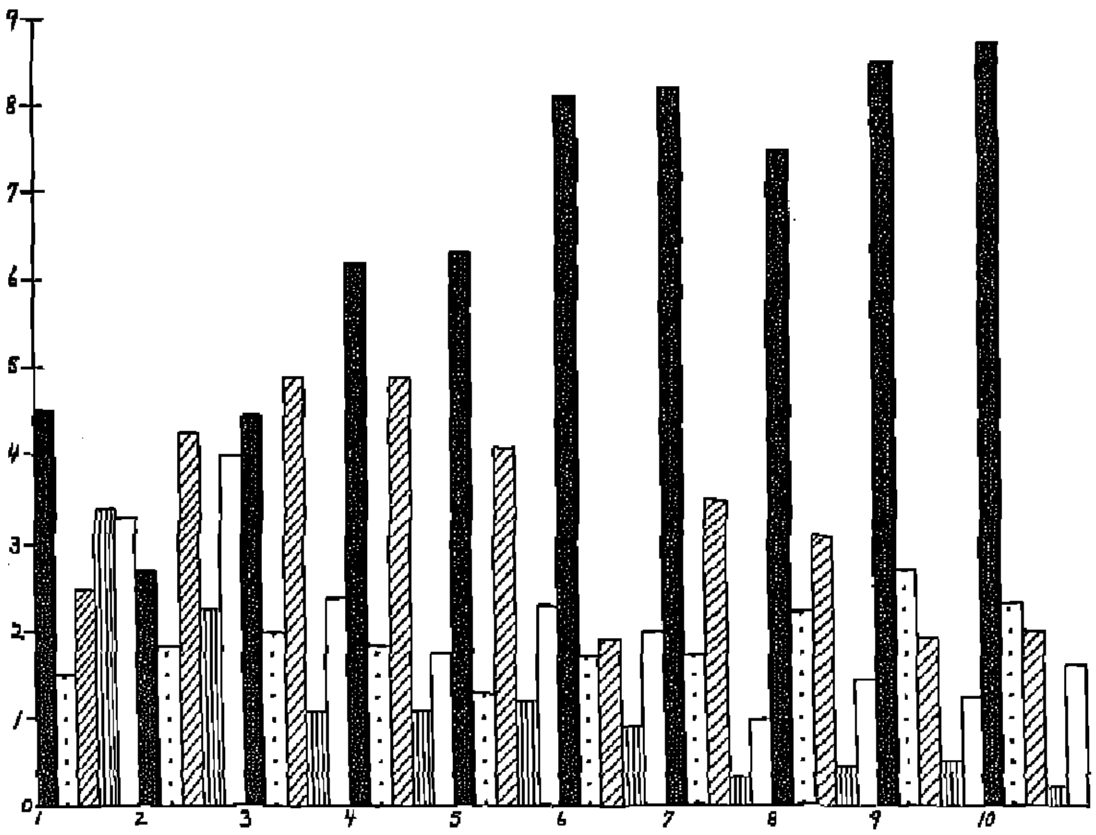

FIG. 4. OLDER GROUP, SHOCK USED THROUGHOUT

A group histograph in which are illustrated the types of responses on each trial for 10 trials. The successive trials are given on the abscissa; the average number of responses to 15 stimuli for the group is indicated on the ordinate. The solid column represents the synchronizations made; the doted column, the number of anticipations; the oblique-line column, the number of lags; the vertical line column, the number of asynchronizations; and the blank column, the number of omissions.

The results of these three groups may be contrasted and summarized as:

1. Learning occurred in all three groups as was indicated by the increase in the number of synchronizations, and the decrease in the number of all types of errors.

2. The process of the learning appeared in the two children's groups to be: (1) all types of responses with no one type predominating for the first few trials; (2) differentiation was first shown by the decrease in the number of asynchronizations and omissions made and slight increase in the number of synchronizations made; (3) further differentiation was shown by fewer asynchronizations and omissions, a decrease in anticipations and lags, and a definite increase in the number of synchronizations made. The modification in responses by adults consisted in the decrease first in the asynchronization error and then in the lag and anticipation errors.

3. The older group of children made more correct responses on the first trial than did the younger group; and further, they showed the differentiation of responses at an earlier stage. The adults made many more correct responses on the first trial than did the older group of children and their increase in correct responses began earlier than the children's. These facts, although based upon results of small groups show clearcut age differences in the ability to cope with the conditions of this problem.

TABLE 4

TYPES OF RESPONSE	TRIAL I				TRIAL V				TRIAL X			
	1	2	3	T.	1	2	3	T.	1	2	3	T.
A	13.6	13.5	13.5	40.6	13.8	14.5	14.3	42.6	15.1	14.5	14.5	44.1
B	0.1	0.1	.05	.25	.05	.05	0.1	0.2	.05	0.0	0.0	.05
C	1.2	1.3	1.4	3.0	1.1	0.4	0.2	1.7	0.2	0.4	0.5	1.1
D	.05	.05	0.0	0.1	0.0	0.0	0.0	0.0	.05	0.0	0.0	.05
E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Average number of each type of response for trials I, V, and X for adults. The vertical columns numbered 1 represent the response to the first 15 stimuli presented without shock; columns numbered 2, to the second 15 stimuli accompanied by shock; columns numbered 3, to the third 15 stimuli accompanied by shock; and columns lettered T, to the total of 45 stimuli. Row A represents the average number of synchronizations; row B, anticipations; row C, lags; row D, asynchronizations; row E, omissions.

RESULTS OF GROUPS FOR WHOM THE *SHOCK WAS REMOVED AT THE END* OF THE FIRST FEW TRIALS

Younger group

In table 5 is given the average number of each type of response for the first, fifth, and tenth trials. It may be noted that for this group all types of responses increase in number, the number of synchronizations showing the greatest increase. Each child on the average made seven times as many correct responses on the tenth trial as he made on the first. The predominant type of response throughout

the series was that of anticipation; the least frequent response was the asychronization type. A notable failure to react. Only after the shock was removed did the children really start reacting positively to the problem.

TABLE 5

TYPES OF RESPONSE	TRIAL I				TRIAL V				TRIAL X			
	1	2	3	T.	1	2	3	T.	1	2	3	T.
A	1.0	0.5	0.1	1.6	3.0	1.1	2.3	6.4	3.1	2.5	2.1	7.7
B	4.3	2.1	1.8	8.2	5.0	5.1	4.4	14.5	4.9	5.0	6.0	15.9
C	2.1	1.4	1.4	5.0	4.0	4.0	2.2	10.2	2.6	3.5	2.3	8.5
D	2.1	0.5	0.5	3.4	1.1	1.0	1.5	3.7	1.6	1.8	1.5	5.0
E	5.5	10.1	11.1	26.8	1.8	3.4	3.8	9.1	2.8	1.6	2.8	7.3

Average number of each type of response for trials I, V, and X for the younger group with shock removed. The vertical columns numbered 1 represent the response to the first 15 stimuli; columns numbered 2, to the second 15 stimuli; columns numbered 3, to the third 15 stimuli presented; and columns lettered T, to the total of 45 stimuli. (Shock was removed after the second or third trial.) Row A represents the average number of synchronizations; row B, anticipations; row C, lags; row D, asynchronizations; row E, omissions.

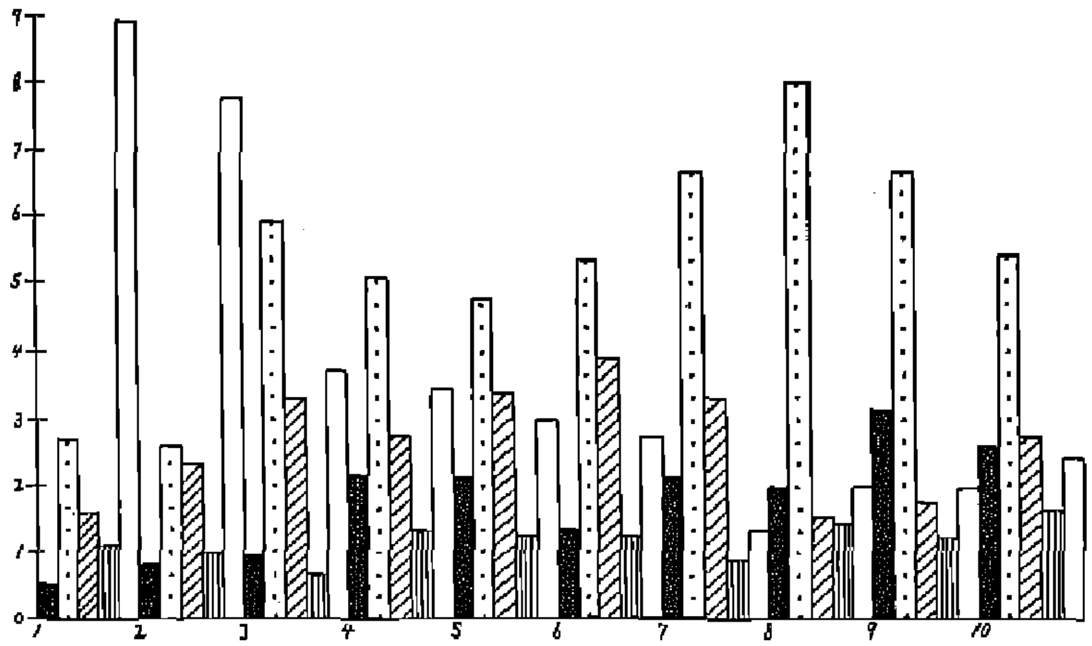

FIG. 5. YOUNGER GROUP, SHOCK REMOVED

A group histograph in which are illustrated the types of responses on each trial for 10 trials. The successive trials are given on the abscissa; the average number of responses to 15 stimuli for the group is indicated on the ordinate. The solid column represents the synchronizations made; the dotted column, the number of anticipations; the oblique line column, the number of lags; the vertical line column, the number of asynchronizations; and the blank column, the number of omissions.

fact brought out in this table is the large reduction in the number of omissions. The typical mode of behavior to the shock in this group was

These facts are shown more clearly by the graph in figure 5 which gives the types of responses for each of the ten trials. Here it is clearly seen how

as soon as the shock is removed, the level of the columns representing the number of omissions drops quite low and remains so throughout the series. For trials 3 to 7 the anticipation and lag type of reaction predominate, although there is a slight increase in the number synchronized. From the seventh trial on the anticipation type becomes outstanding and the number of syncronizations increases to some extent.

rors and correct responses, the partially correct responses constituting an intermediate stage in the process. The majority of reactors progressed by reducing the asynchronization and omission stage first, then reducing the partially incorrect responses. It may be concluded that learning has occurred in the reduction of absolutely incorrect responses, although the stage of perfect synchronization has not been reached.

TABLE 6

TYPES OF RESPONSE	TRIAL I				TRIAL V				TRIAL X			
	1	2	3	T.	1	2	3	T.	1	2	3	T.
A	1.8	1.0	0.2	3.0	4.4	2.8	1.0	8.2	1.2	2.0	2.0	5.2
B	3.8	2.0	1.4	7.2	4.0	4.4	4.8	15.2	5.5	4.2	5.0	14.7
C	2.8	1.0	1.2	5.0	2.8	1.6	3.0	7.4	4.7	4.2	4.0	12.9
D	3.0	1.0	1.0	5.0	2.0	2.6	1.8	6.4	1.5	1.2	1.0	3.7
E	3.6	9.2	11.0	23.8	2.2	4.2	4.0	10.4	2.0	2.2	3.0	7.2

Average number of each type of response for trials I, V, and X for the older group with shock removed. The vertical columns numbered 1 represent the response to the first 15 stimuli presented; columns numbered 2, to the second 15 stimuli; columns numbered 3, to the third 15 stimuli; and columns lettered T, to the total of 45 stimuli. (Shock was removed after the second or third trial.) Row A represents the average number of synchronizations; row B, anticipations; row C, lags; row D, asynchronizations; row E, omissions.

The high anticipation and lag curve rather than a high synchronization curve at the end of the series might be expected for this group, because of the fact that when making either one of these types of reactions, no warning was given and no factor was present to bring about a correction. But it might be concluded that a certain degree of learning did occur with this group in the sense that the errors of greatest extent decreased the most, and the partially correct responses increased in number. This would hold only under the assumption that a gradation exists between the absolute er-

Older group

In table 6 is presented the average number of each response for trials 1, 5, and 10. It may be noted from this table that the number of correct and partially correct responses increases, while the number of asynchronizations and omissions decreases. The anticipation type of reaction is the predominant type of reaction throughout the series. Figure 6 illustrates these facts even more clearly. The shock was removed on later trials for this group than for the younger group, but the reduction of the number of omissions

is quite noticeable. The large differentiation in response comes clearly on the eighth trial, when the anticipation type increases decidedly and all other types of errors decrease in number to a large extent.

The results of these two groups may be summarized and compared as: (1) a certain degree of learning occurred in that there was a decrease in the most erroneous types of reactions and an increase in the correct and partially correct types of response; (2) the predominant type of response was that of anticipation for both groups; (3) the typical form of behavior when the shock was used was that of failure to react.

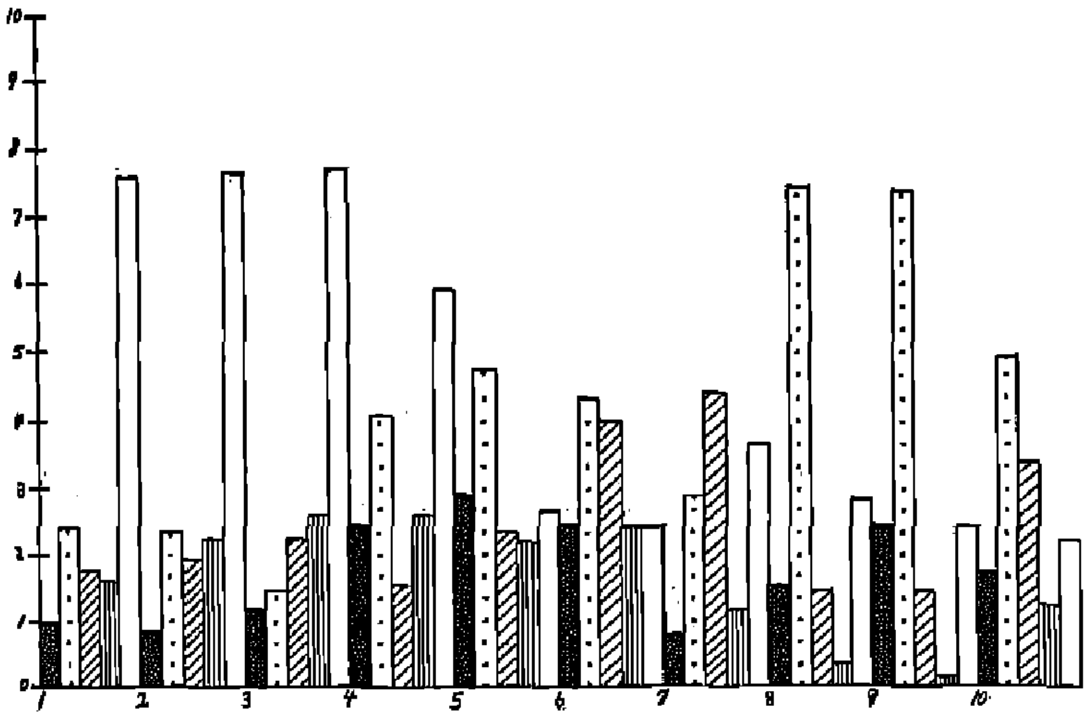

FIG. 6. OLDER GROUP, SHOCK REMOVED

A group histograph in which are illustrated the types of responses on each trial for 10 trials. The successive trials are given on the abscissa; the average number of responses to 15 stimuli for the group is indicated on the ordinate. The solid column represents the synchronizations made; the dotted column, the number of anticipations; the oblique-line colunn, the number of lags; the vertical line column, the number of asynchronizations; and the blank column, the number of omissions.

EFFECT OF THE SHOCK

(1) It might be said that there were two general types of response to the stimulus pattern. By one (groups receiving the shock throughout) the general attitude was to avoid the shock by paying more careful attention to each reaction, attempting to press the key at just the right time. By the other (groups having the shock removed) the general attitude was to avoid the shock by simply not reacting. This factor for the entire experiment had to be overcome before a good synchronization record could possibly be obtained.

(2) For the groups who received the shock throughout, a greater amount of learning occurred than with the group that had the shock removed. So that for the entire series it might be concluded that the shock was beneficial for the learning process. Its effectiveness was probably in its corrective value. That is, that by the shock the

subjects were aware of any error they made. However, in any one trial it was found that more synchronization reactions and fewer errors were made to the stimuli not presented with shock than to the stimuli accompanied by the shock. (The writer is cognizant may be surmised, however, from the results found, that with such a group, the partially correct responses would predominate, because the directions would be followed and no check would be made on a slight anticipation or lag reaction.)

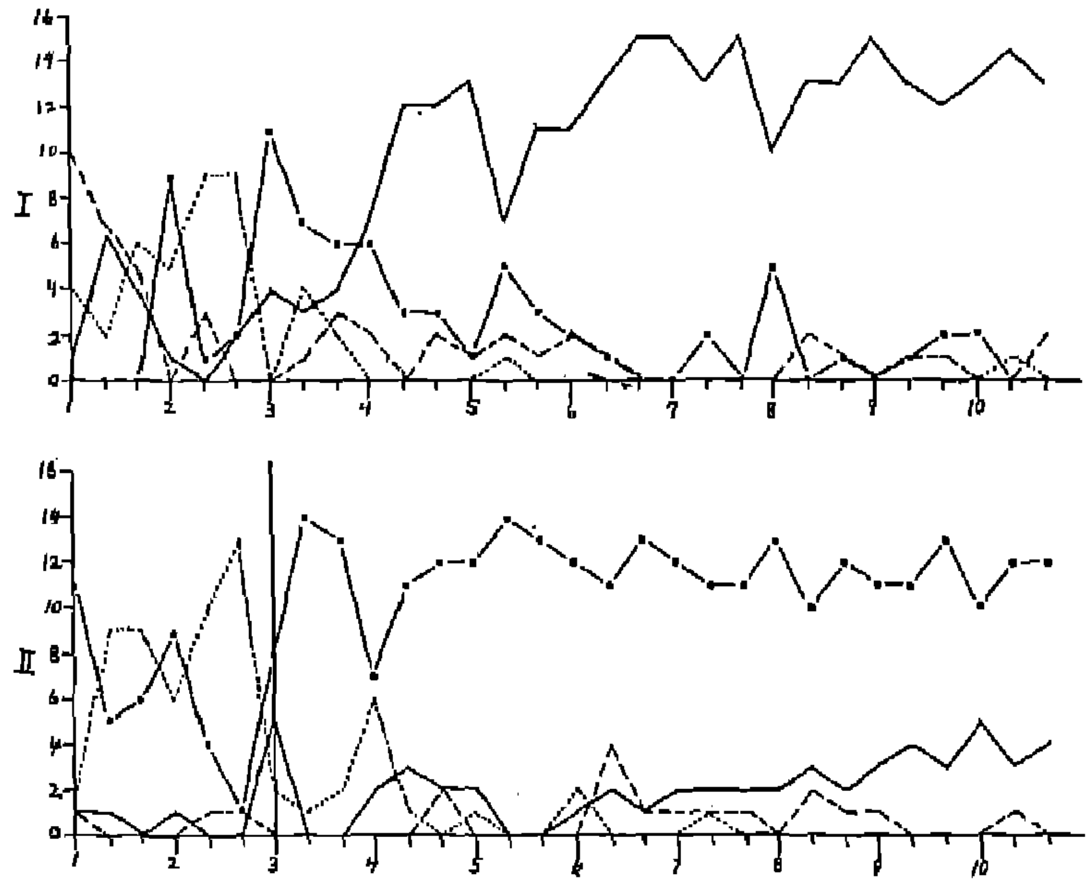

FIG. 7. SETS OF CURVES FOR TWO INDIVIDUALS IN WHICH ARE SHOWN THE TYPES OF REACTION ON EACH TRIAL FOR 10 TRIALS

The abscissa represents the successive trials; the number of responses to each 15 stimuli is indicated on the ordinate. The solid line represents the number of synchronizations made; the dot and dash line, the number of anticipations plus the number of lags; the broken line, the number of asynchronizations; and the dotted line, the number of omissions. Set I is of a child in the older group, shock used throughout; set II, child in the younger group, shock removed.

of the fact that a comparison of the results of these two main groups with regard to the shock is not conclusive except for the effects as such, due to the fact that the shock was administered to all children at some time in the experiment. There was no group which learned the problem without experiencing the electric shock. It

INDIVIDUAL DIFFERENCES

In each group wide individual differences were found. Figure 7 illustrates two sets of curves of individuals' responses made throughout the series. From these it may be suggested that no two individuals progressed in the same way.

SEX DIFFERENCES

(1) In the children's group no girl received the shock throughout. The girls showed much more "emotional disturbance" than did the boys.

(2) Of the group who did not receive the shock the boys had a slightly higher average of correct responses than did the girls.

(3) Of the adults, the men were slightly superior as to the number of correct responses made to the women, and the men showed an increase in the correct responses at an earlier stage than did the women.

(These sex differences are given as suggestive differences only, as conclusive statements could not be made upon the results of such small groups.)

SUMMARY AND CONCLUSIONS

The *problem of learning to make* rhythmic responses was studied with such instrumental control that evidence was obtained on the various stages in the learning process. The types of responses at each stage of learning showed modifications through which more accurate synchronization was established. The types of responses made fell largely into five well-defined categories;—synchronizations or correct responses, in which the complete reaction was made during the flash of light; asynchronizations or complete misses, in which the complete reaction was made when the light was off; anticipations, in which the reaction was commenced prior to the flash but was completed while the light was on; lags, in which the reaction was commenced while the light was on but was completed when the light was off; and omissions, in which case there was failure to react to a stimulus.

Twelve children were too "disturbed" by the shock to continue with the experiment unless the shock was removed. Because it was thought desirable to ascertain the reactions of these children to the problem, the shock was eliminated for this group after the third or fourth trials.

The types of responses which were elicited throughout the series by the entire group of children who received shock in each trial were: (1) no one type of response predominated in the first three trials (2) the number of *synchronizations* increased *steadily so* that in the last few trials, this type of reaction predominated; (3) of the errors made, the lag type occurred most frequently; (4) the asynchronizations and omissions were few in number by *the end of the series.*

The types of responses which were made in the series by the group who had the shock removed were: (1) failure to respond until the shock was removed; (2) when reactions were made during the shock trials, few were accurately synchronized; (3) for the last few trials, the anticipation type of reaction increased rapidly in number and was the predominant type of response; (4) the number of synchronizations increased slightly toward the end of the series; (5) relatively few asynchronizations and omissions were made in the last trials.

The types of response for adults were: (1) the synchronization type of reaction was predominant throughout the series; (2) the lag type of error was the most prevalent error made;

(3) some form of reaction was made to every stimulus presented.

CONCLUSIONS

1. Learning occurred for all groups. For those who received the shock throughout, the learning was more rapid and continued to a higher level than for those who did not.

2. Wide individual differences and methods of learning occurred in all groups.

3. The effects of the shock were: (a) seeming "emotional disturbance" on the part of all the girls in the children's group, and on the part of some boys; (b) of those who showed such disturbance, the typical mode of behavior was failure to react. Only after the shock was removed, was the problem attacked; (c) a greater extent of learning occurred from those who received the shock throughout than from those who did not; (d) of those who received the shock throughout, in any one trial more synchronizations were made to the stimuli when the shock was not used.

4. Age differences found were: (a) the adults began at a higher level of correct responses than did the children, and increased in the number of correct responses at a faster rate; (b) the older group of children began at a higher level than did the younger group and showed differentiation of response at an earlier stage.

5. The sex differences found were: (1) for the children, no girl received the shock for the entire series; (2) more "emotional disturbance" was manifested when the shock was used by the girls than by the boys; (3) of the group who had the shock removed, the boys synchronized on the average more times than did the girls; (4) for the adults, the men were slightly superior to the women. Fewer errors were made, and the errors were eliminated on the average at an earlier stage by the men than by the women.

(Note: The complete data for this experiment may be obtained from the doctoral dissertation on file at the Johns Hopkins University.)

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Biographical Records of Memory in Pre-School Children

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BIOGRAPHICAL records of the memory of pre-school children show how the memory of the normal child in a normal environment grows during the period from birth to six years. They also show how the latency period, or the interval which elapses between an event and the memory of it, increases with the age of the child.

To obtain the latency period, it is necessary to have not only the exact age of the child but also the length of time elapsing since the original occurrence of the experience and the memory of it. Such exact material can, as a rule, be obtained only from diaries, and even these often fail to give the necessary dates.

I. RECORDS OF MEMORY IN THE FIRST YEAR OF LIFE

References to memory during the first year of life are fewer than in later years, and many of those on record appear to be inaccurate in content, as many biographers read meanings into the child's behavior which are not justified by the facts. Dearborn (9) page 77 for example, records that a child of five months of age remembered a person over a period of eighteen weeks. This statement, judged on the basis of other records, cannot be accepted without questioning its accuracy.

Memory, during the first year, extends, as a rule, merely to impressions but lately experienced. The latency periods are brief and only gradually increase in length. The following records, taken from the works of different biographers, are arranged in sequence of age. The age of the child expressed in years and months, is put in brackets at the beginning of the quotation. The first numeral indicates the year and the second indicates the month. For example, (2;11) signifies that the child is two years and eleven months old. Where the latency period is given or could be secured it has been put in italics.

(0;3) Another child, at four months, noticed at evening the absence of his nurse, who had been gone only *a day* and cried lustily upon the discovery, looking all about the room, and crying again every time after searching in vain Preyer (24) p. 7.

(0;4) The day before the baby held up her rattle; to look at she declined to go to sleep in her mother's arms, and kept lifting her head to look at me, till I crossed the room and put myself out of sight. *Presently* she lifted her

[1] The junior writer was responsible for collecting the data used in this report; the senior writer supervised the research and helped to prepare the manuscript for publication.

head again, turned round, and searched persistently the quarter of the room toward which she had seen me disappear. Shinn (29) p. 147.

(0;5) Then he stuck his finger into his mother's laughing mouth; she bit on it; Bubi, amazed, raised his brows and looked at her as though questioning. When his mother again bit, he crowed with content, but drew back his hand. *After a brief pause*, he spontaneously stuck his finger into his mother's open mouth and looked highly expectant as he did it. Scupin (27) p. 19.

(0;5) Twenty-fourth week. He recognized his grandfather whom he had not seen for *2 weeks*. Moore (21) p. 100.

(0;6) Her nurse who had been with her continuously for five months was absent for a period of *3 weeks*, and on her return was instructed first to appear to the child simply in her usual dress but to remain silent, then to withdraw from sight and speak as she had been accustomed to; and finally to appear and sing a nursery rhyme, which by special care the little girl had not been allowed to hear during the nurse's absence. The first result was that the child gazed in a questioning way upon the face, but showed no positive signs of recognition; yet the absence of positive fear and antipathy shown at first toward the substitute nurse indicated that the visual image was not entirely strange. The tones of the nurse's voice were not at all recognized, as far as passive indications even of familiarity were concerned. The third experiment was attended by complete and demonstrative recognition. Baldwin (1) p. 316.

(0;7) 228th day. His father, whom the child had not seen for *2 weeks*, was greeted with outstretched arms while still two hundred feet away. From this time he was recognized a quarter of a block away. Hall (14) p. 465.

(0;8) A child of this age recognized her nurse *after 6 days absence* with "sobs of joy". Tracy (35) p. 48.

(0;9) Another (girl) recognized her father after a separation of *4 days*. Preyer (24) p. 7.

(0;9) 279th day. She seemed to recognize her grandmother whom she had not seen for *some weeks*. Dearborn (9) p. 114.

(0;10) Crying on going to bed in a strange room. By night the boy has accustomed himself to it.
[Note:—*from noon to night*.] Scupin (27) p. 54.

(0;10) 327th day. His uncle showed him his watch, and blowing upon it caused the cover to fly open. He then allowed the child to "blow it open". *Three days later* the boy held his father's watch to my lips, making at the same time the blowing noise plainly asking to have the cover blown open. Hall (14) p. 530.

(0;11) 338th day. Her memory for photographic portraits is now such that she remembers her numerous uncles, etc. apart, at least *a week*. Dearborn (9) p. 124.

(0;11) In the second week of the month her uncle showed her how he lifted the window-sash, and *4 days later*, catching sight of the finger handle, she tugged at it with impatient cries, trying to make the sash go up. Shinn (29) p. 244.

(0;11) A little girl recognized her nurse after *6 days absence*, immediately, "with sobs of joy". Preyer (24) p. 7.

Summary

The important characteristics of the memory of the first year of life, as recorded by baby biographers, may be summarized as follows:

1. The first signs of remembrance, although very fleeting, show themselves before the end of the first year of life.

2. During the first year, memory is, with few exceptions, strictly limited to some few people or things which the child has seen repeatedly. Mem-

ories for situations, because of their complexity, are relatively few in number.

3. Of the references to memory in the first year (only a few of which have been recorded above)

44.44% record memory for persons
37.78% record memory for objects
17.78% record memory for situations

4. In the records of memory in the first year, memory was always aroused by a sensory stimulus. Memory of this type, which is the only kind recorded at this age, is of a lower order than memory where no sensory stimulus is present.

5. The most frequent latency period is twenty-four hours and this increases towards the end of the year to five or six days.

6. Even as early as the first year of life, memory is greatly influenced by the emotional quality of the impression concerned. Painful impressions tend to leave a mark not easily wiped out.

II. RECORDS OF MEMORY IN THE SECOND YEAR OF LIFE

The records of memory during the second year are greater in number than during any of the other pre-school years. A possible explanation of this is that during the first year, the baby has neither experiences nor the capacity to remember. In addition to this, the baby has not the means, namely language, to express what he does remember. After the third and fourth years, there are so many things that the child remembers that biographers have been obliged to limit their records to exceptional cases of memory.

(1;0) The first impression of a humming fly was so lasting that the child, even after *hours* had passed, looked searchingly up and down the window in response to the question, "Where is the fly?" Scupin (27) p. 52.

(1;0) I saw no indication in the first year that she ever looked really away into the distance; but the day she was a year old she proved to know the moon, pointed out to her by someone *3 days* earlier. Shinn (31) p. 20.

(1;1) 58th week. He recognized a person whom he had seen but once, and for a few moments, *3 days* before, but by whom he had been hurt. Moore (21) p. 50.

(1;2) 426th day. *A week* after he had watched a kitty lap milk, I said to him as he drank his milk; "Albert drinks milk and kitty drinks milk," whereupon he stopped drinking and began a vigorous lapping. Hall (14) p. 525.

(1;3) 473d day. After a day in the park, where the child had seen the boys catching tadpoles in the covers of their tin pails and had seen the dog pushed into the water, he told his father with great animation; "Tadpole, water; boy, cover," and then almost crying, added, "Bow-wow, water." It was evident *two weeks* later that he still remembered the scene, as, after he had spilled some water and had been told, "Now see, your hand is all wet," repeated "all wet," then, as his face assumed a sympathetic look, he added; "Bow-wow, all wet." Hall (14) p. 526.

(1;4) The little girl M. when nearly seventeen months old received her father after only *5 days*' absence with special marks of tenderness, rushing up to him, smoothing and stroking his face and giving him all the toys in the room. Sully (34) p. 243.

(1;5) One *morning* her mother told her she was going ta-ta that evening to Somerville. When *evening* came she said, "Now mother is going ta-ta." Baby pointed out of the window to Somerville, which was just opposite,

thus indicating her comprehension. Drummond (10) p. 9.

(1;5) 75th week: A little playmate who had been away for *4 weeks* was upon his return immediately recognized. He was seen for the first time in his wonted surroundings. Moore (21) p. 102.

(1;6) On a certain evening in the latter part of the nineteenth month, I pointed out and named the moon for him. *Three evenings* later, he accidently caught sight of the moon, reached toward it and cried, "Moom." Major (20) p. 211.

(1;7) 83d week: One day, his mother, after blackening her own shoes, seated the child on a chair and blackened his. *Ten days* later he entered the room while his mother was blackening her shoes, climbed on a chair and held out his feet to have his done. Moore (21) p. 104.

(1;9) 659th day. I now showed her the difference between light and dark green. She at once grasped it, and named them correctly half a dozen times. *A week* later, I showed her the light green, and asked, "What kind of green is that?" "Light green." "And that?"—She hesitated; "Black green—no!" I gave her the word dark, and then altered the positions and asked for it, and *she selected it promptly*. Shinn (31) p. 52.

(1;10) On the 20th of July he came to a place of the house where he had been punished the *preceding week* because he had soiled it, and without further provocation he said at once that anyone who soiled the room gets a whipping. Tiedemann (36) p. 39.

(1;10) 98th week: He recognized at once a great variety of pictured boats, which was noteworthy, as *22 weeks* had elapsed since he had seen ocean or boat, and the pictures were unlike any which he had in the meantime looked at. Moore (21) p. 113.

(1;11) . . . . a boy manifested keen delight on again seeing his playthings after an interval of *11 weeks*. Tracy (35) p. 49.

(1;11) When he reached the station he met his cousin and called him by name, although he had not seen him for *4 months*. Hogan (16) p. 65.

Summary

1. In the second year, memory ceases to be made up of mere fleeting impressions. The latency period increases so that objects and persons are recognized even if they have not been seen for some weeks.

2. Of the records of memory in the second year (only a few representative ones have been given above);—

15.68% record memory for persons
43.24% record memory for objects
41.08% record memory for situations

3. In comparing these data relating to memory in the second year with that of the first year, the most significant fact is the great increase in memory for situations; the problem of action as contrasted with the mere sight of an object or person is coming to be an important factor in determining memory.

4. The objects remembered are of a more complex nature than those remembered during the first year. Although not very accurate and having but a short latency period, there are records of memory for colors, figures and numbers, of which there are no examples in the first year.

5. The emotional quality of the event influences the memory of it. Vividly interesting, pleasing or painful experiences are retained for a longer time than those of neutral tone.

6. In the first year, it was noted that some definite sensory experience asso-

ciated with the remembered thing was necessary to arouse the memory of it. But, the child of two years no longer needs a sensory stimulus. He has achieved the elements of adult memory, i.e., memory as a part of a train of thought, and even the factor of voluntary recall is present.

7. The most frequent latency period of the second year is two to three weeks. The longest period recorded is nine months.

III. RECORDS OF MEMORY IN THE THIRD YEAR OF LIFE

By the third year of life, memory is beginning to assume the characteristics of adult memory. The child consciously remembers things, even those of a complex nature, and mere recognition of a person or object as such is no longer significant The latency periods which have been increasing in length during the two preceding years, continue to increase during the third year.

(2;0) R.'s grandfather gave him a toy and spent the evening in showing the child how to play with it. The toy was then put away and grandpa returned home. When, after an interval of *two weeks*, the toy was again given to the child, he said, "Dahon" (grandpa). Major (20) p. 213.

(2;0) The mother of a two-year-old child had made for it out of a postal-card a sled (Schlitten) which was destroyed after a few hours, and found its way into the waste-basket. Just *4 weeks* later another postal-card comes, and it is taken from the carrier by the child and handed to the mother with the words, "Mamma, Litten!" This was in summer when there was nothing to remind the child of the sled. Soon after the same wish was expressed on receipt of a letter. Preyer (24) p. 10.

(2;1) . . . . a girl started playing creep mouse when the place and other conditions were the same as when she played *3 months* before. Kirkpatrick (18) p. 106.

(2;2) At this time the child showed that she had some color memory, for not having seen me for about *3 weeks*, she recalled that I had then been wearing a jacket with red buttons. Drummond (11) p. 60.

(2;2) During to-day's visit to his grandmother's dwelling, which the child had not visited for *almost a year*, he ran immediately to the Cuckoo-clock, and said expectantly, "Cuckoo!" Scupin (27) p. 115.

(2;3) Gunther after a holiday in the Riesen gebirge. His principal remembrance was the cowshed, as he showed by the herdboy's characteristic call beda, beda, and by crying out "hild cow." Every day he played too, puff-puff, in recollection of the railway. *Three and a half weeks* after our return we also questioned him to test the presence of definite recollections. We asked him about our host's dog, about the village children with whom ours had played, about the stable inmates, and in his simple language he could answer us on every point. Stern (33) p. 240.

(2;4) On seeing its box, the boy remembered his doll at once . . . . after an absence of *6 weeks*. Scupin (27) p. 128.

(2;4) After *6 weeks'* absence Gunther recognized his home as a matter of course. Stern (33) p. 218.

(2;5) . . . . the child went away for the the summer and did not see, or so far as I know, think of the colored cards or pictures again for a period of *6 weeks*. I then got out the cards and asked, "Where did you used to see these?" He answered at once, "Papa's oom;" that is, in papa's room. The cards were associated with that particular room. Major (20) p. 214.

(2;5) When two years and three months old, he had been staying for a month or so at a farmhouse in a little sea-side village, D——, where there was a sheep dog named Bob. Some 3½ *months* later he happened, during one of his walks in his London suburb, to see a sheep dog, whereupon he remarked, "Dat old Bob, I dink." Sully (34) p. 437.

(2;6) Hilde. On her return from a change lasting *6 weeks*, when we got out of the carriage before our house, she absolutely stamped with delight and said, 'Home, home.' When we got in, she *ran through the rooms* with unhesitating delight and surprise, recognizing everything, 'pretty table, pretty window, Hilde's cupboard,' she kept on repeating. Stern (33) p. 820.

(2;7) A girl of thirty-one months truly said that some stitches in her dress had been made by her grandma, although *2 months* had elapsed since the dress was made. Kirkpatrick (18) p. 106.

(2;8) On April 7, 1904, she picked up an archeological pamphlet, opening it at a page containing a picture of a skeleton lying in a grave She exclaimed at once: "Like zose at nuwersity!" *About a month* before, she had been taken by her father to his room in the University, where were several mounted skeletons of infants. Chamberlain (4) p. 268.

(2;8) When two years and two months old he had been staying for a month or so at a farm house in a little sea-side village D—— . . . . *Six months* after this visit, on being asked what honey was, he remarked that he had had some at D——. Sully (34) p. 438.

(2;9) . . . . child remembered, after an interval of *7 weeks* that he had seen pigs in a shed at a live-stock exhibition. Major (20) p. 214.

(2;10) Showed by his play with his doll, that he recalled having passed the night away *25 days* ago. Scupin (27) p. 182.

(2;10) . . . . a little boy when taken to Italy a second time after *4* or *5 months'* absence remembered the smallest details, e.g., how the grapes were cut, how the wine was made, and so forth. Sully (34) p. 60.

(2;11) He was impressed by the seemingly prosaic incident of an expressman's calling for his mother's baggage, and he related *8 weeks* afterwards with great color that "Man git mamma kucks (trunks)—put on wagon—know at?" Major (20) p. 215.

(2;11) Mary T——, an old playmate, who used to come regularly to play with him, came to see him a few days ago. He was so delighted to see her that he hovered over her all the time she was with him. He paid no attention whatever to me. He said to her once "I love you, Mary." He had not seen her for *a year*. Hogan (16) p. 136.

Summary

1. The data for the third year shows that, of the cases of memory selected,

11.25% record memory for persons
35.00% record memory for objects
53.75% record memory for situations

This does not mean that the child's memory is weaker for persons and objects than for situations, but it can be explained by the fact that memory for persons and objects, as such, are not recorded by the biographers after the second year unless they are particularly significant. In addition to this, the child has, by now, become very much interested in what is going on about him. Those things which interest him make a deeper impression and are remembered for a longer time than are events which did not arouse his interest.

2. In the second year, the child was just beginning to remember colors, while in the third year, memory for colors appears as a well-established fact.

3. An interesting development of the third year is the child's memory for details. The ability to repeat a verse after a period of two months, to tell a story heard the night before, and to describe in detail events which happened in the past, is an entirely new stage reached in the mental development of the child.

4. The most common latency period during this year is from one to two months in length, although latency periods of one year are frequently recorded.

IV. RECORDS OF MEMORY IN THE FOURTH, FIFTH AND SIXTH YEARS OF LIFE

Many biographies of the development of children end with the third year and consequently records of memory from the years three to six are few in number. These years are full of new and interesting experiences for the child, and while there appears to be no markedly new development in memory, impressions are deeper and more lasting than in the preceding years. It is no longer rare to find recollections of occurrences happening many months before with nothing to revive their memory in the interval.

(3;0) . . . . on being shown an engraving of his grandfather whom he had not seen for exactly *6 months*, he instantly recognized him and mentioned a whole string of events which had occurred while visiting him and which certainly had never been mentioned in the interval. Darwin (8) p. 291.

(3;1) On going to a resort in which he had been *10 months* before the boy remembers the names of the mountains Scupin (28) p. 40.

(3;2) She returned after an absence of *21 days;* and as soon as she saw the cake-box, which was broken, she said; "I'd like to mend the cake-box, will you get what's up in the bowl?" I had placed a handle and some other things in a bowl which was in a room where R. had not yet been, so she could not possibly have seen either bowl or handle. Rasmussen (25) p. 141.

(3;3) She suddenly said, without any observable cause; "E. was engaged and she cried because she had said something wrong to grandfather." The reference was to an incident with a maid who had told a lie *4 months and 18 days before*. Rasmussen (25) p. 141.

(3;4) He remembers returning from the summer resort after *61 days*, shells which he had collected there and the mother who cannot find the shells calms him by saying that she gave the shells to another child. Scupin (28) p. 37.

(3;6) When she was two and a half, Margaret spent Chritmas in Edinburgh and played a few times with a solitaire board and marbles. The following Christmas she was again in Edinburgh, and in a friend's house was shown a solitaire board and marbles. She at once came to me and began to inquire about the marbles in my house. I feel quite sure that the memory had not been vivified by any talk in the *year's* interval. Drummond (11) p. 93.

(3;7) . . . . we passed some haystacks, and R. said; "Those are what were at Miss C.'s;" but she could not have seen a haystack since she was in the country, *9 months* back, and she had neither heard haystacks spoken of nor seen pictures of them. Rasmussen (25) p. 142.

(2;9) He recognizes an old lady, whom he had seen about *a year* past, and only for the mid-day meal. Scupin (228) p. 80.

(3;11) Eva—"A zither was casually mentioned in our conversation, and the

word called forth in Eva the recollection of a incident that had occurred *five and a half months* sooner, and in great excitement she poured forth: 'Yes I know a zither; in Krummhubel there was once a blind woman and a man; the man sang and the woman played a zither. They stood by the house Villa Marie and we stood by the tower, and you, Mother, were up in the loggia listening.' Every detail was right, and the incident had never been mentioned since." Stern (33) p. 242.

(4;1) . . . . she saw a picture of a man with a scythe and said; "That's what they reap grass with;" although she had seen nothing of the sort since harvest time, *4 months* previously. Rasmussen (26) p. 53.

(4;2) Remembrance . . . . of a red dress, that had not been used for *2 years* and a definite memory-picture of the time his mother brought the dress to his bed. Scupin (28) p. 99.

(4;4) M., who was to take part in a play, powdered her hair. About *2 weeks* later L. was standing near her. He noticed some white hairs in her head; he said, "Cousin M., you haven't got all that white off your hair yet, and it grows worse. It grows right into your head." (Brown (3) p. 379.

(4;6) Our present nurse put on a blue and white striped blouse, and at once Gunther cried, "You look like Marie, Marie wore a blouse like that." As a matter of fact, a former nurse wore in the summer, when she left us, a blouse almost identical in color and cut with the other maid's. The fact had never been mentioned in the interval of *two and a quarter years*. Stern (33) p. 244.

(4;9) . . . . I showed her (R.) a nettle-butterfly sitting on a flower and said; "We saw one like that at Tisvilde (*a month* before)." R. replied, "Yes, and it's like 'the old fox.' " (i.e. 'The big fox', a picture.) Rasmussen (26) p. 56.

(5;0) Remembers, how he comes into a forest, in which he had once been *a year* ago with his grandparents, on an excursion. He remembers the details of the scene at that time. Scupin (28) p. 158.

(5;2) Remembers that Jockel, the bird, taken away *9 months* ago, played with nails. Scupin (28) p. 203.

(5;5) He met a gentleman who had been kind to him during that memorable visit to the sea-side village D—— just *three and a half years* before, and whom he had not seen since. His father asked the child whether he knew Mr. S——. He looked at him steadily, and answered "yes." Asked where he had seen him, he answered: "Down at——." He had forgotten the name of the place. On his father further asking him what he remembered about him he said: "He made me boats and sailed them in a pool." This was quite correct. So far as the father can say the fact had not been spoken of to him since the time. If this is so, it seems worth recording that a child of five and a half should recall such distinct impressions of what had occurred when he was only just two. Sully (34) p. 481.

(5;11) When Bubi saw rhubarb after a year, he attempted to remember the name, he sighed, stuck his head in his hands, and winced as if struck, then looking at the rhubarb, he said: 'Barberaba.' Scupin (28) p. 219.

Summary

1. In the biographical records of memory in the fourth, fifth and sixth years.

16.66% record memory for persons
15.00% record memory for objects
68.33% record memory for situations

Situations have become the most significant factor in determining memory in the child from three to six years of age.

2. In this period, there is a marked development in memory for complex situations and details.

3. The latency periods have also become much longer, with the most frequent periods from nine months to one year. The longest period is three and one half years, as recorded by Rasmussen (26) p. 57, and Sully (34) p. 481. Both authors record the memory of situations with many details. In the one place, the memory had pleasant, and in the other, unpleasant emotional qualities.

GENERAL CONCLUSIONS

In tracing, by the use of biographical records, the development of memory in children from birth to six years of age, the following conclusions have been reached:

1. Memory, of an impressionistic kind, appears in the first half year of life. The first instances of true remembrance appear by the end of the first year.

2. Memory, in the first year, is only aroused by a sensory stimulus, but, by the end of the second year, a sensory experience is no longer necessary to reinstate memory. It has developed into a more ideational type of experience.

3. During the first two years, memory is stronger for persons and objects than for situations. But, in the years from three to six, persons and objects *in* situations have become the significant factors in the child's memory.

4. Unusual events and things which are interesting to the child have a longer latency period than neutrally toned events. The emotional quality of the impression influences the memory of it.

5. The child recognizes and remembers colors and forms in the second half of the third year.

6. At the age of three years, the child is able after a few days to recount a story heard, and give detailed information about past experiences.

7. Even up to six years of age, the child has, according to these records, no accurate idea of time.

8. The latency period increases in length from birth to six years as follows:

[Note:—The following data give the most common periods found for these years, but not the maximum periods.]

During the first year the latency period is about five days.

During the second year the latency period is two to three weeks.

During the third year the latency period is two to three months.

From the fourth to the sixty year the latency period is one year, with a maximum of three and a half years.

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An Analysis of the Conversation of Children and Adults

Margaret Morse Nice

WHILE working over the results of the all day conversation of our daughter R at four years (5), I discovered that an hour's conversation could serve almost as well as the whole day's record in picturing the subject's skill in speech, since the proportions of the parts of speech of the total words were almost identical, differing only from 0.1 to 2 per cent, while the most used words were also in striking agreement. The proportions of the different words were less significant, accounting for the following percentages in the all day and hour records respectively: nouns 41.4, 30.7; verbs 27.6, 30.7; pronouns 4.3, 8.8; adjectives 12.4, 11.8; adverbs 9.5, 13.4; prepositions 2.5, 3.1; conjunctions 1.9, 0.5; interjections 0.4, 1.0.

In order to study the character and composition of speech at different ages, I recorded a thousand or more words in consecutive sentences of my daughters as follows: one example at thirty months; two at three years and one at four; two at five, one at eight, and one at ten. Finally I collected two samples from adults, one from the children's father, the other general conversation from five people in our family. Ordinary conversation in the course of household activities made up a considerable portion of all the records; the children were also occupied with play, while the adults engaged in discussions of theoretical interest during a part of the time. No subject suspected that his or her words were being taken down. Since R's first hour had consisted of 900 words, I used this same amount of conversation in the other cases. With the adults the average of the two records was taken.

These conversations give examples of the three sentence stages described in an earlier paper (6). The early sentence that averages more than one word and less than three is represented by T's record at two and a half years where her sentences averaged 2.7 words. The next three examples are of the short sentence stage, where H at three years had an average sentence length of 4.4 words, D at the same age 3.8 words and R at four 4 words. The average sentence length of the four older children were as follows: R and E at five 6.2 words each, D at eight 6.9, and E at ten 8.5. The sentences of the adults averaged 9 words.

The ages of the children in the first two stages must not be taken as typical, for each of the four was somewhat slow in learning to talk. Most children of thirty months are in the short sentence stage; at three years perhaps

half the children have passed into the established sentence stage, and only those retarded in speech have not attained it by four. E must have reached the short sentence stage somewhere around her second birthday; she was certainly well in the established sentence period at thirty-four months. D, H and T reached this stage at about the age of three and a half years. Hence, the reader must not conclude that my findings have any definite relation to age, but rather to the stage of speech development.

PARTS OF SPEECH OF THE DIFFERENT WORDS

T at the age of thirty months had a vocabulary of 318 words of which 57.8 per cent were nouns and 19.3 verbs. In the conversations she used far more nouns than any other part of speech, fewer verbs than adjectives, and very small proportions of pronouns, prepositions and conjunctions.

The percentages of the different parts of speech in the conversations of the older children are very uniform, showing in comparison to the baby a decided decrease in nouns, adjectives and exclamations; and a decided increase in verbs, pronouns, prepositions and conjunctions. The adults show somewhat more nouns and prepositions, and somewhat fewer pronouns and adjectives than the children in the established sentence stage.

TABLE 1

Percentages of the parts of speech of the different words

	EARLY SEN-TENCE	SHORT SENTENCE		ESTABLISHED SENTENCE		ADULT
		Range	Average	Range	Average	
Nouns	35.8	23.3–31.7	28.1	24.0–27.3	25.7	30.0
Verbs	19.2	28.0–30.6	29.6	21.0–30.2	27.2	28.7
Pronouns	3.3	0.1– 0.4	9.2	8.0– 9.7	8.7	6.9
Adjectives	20.0	12.4–14.6	13.5	13.9–19.0	16.2	13.1
Adverbs	14.2	13.4–15.2	14.2	11.3–17.9	13.9	13.1
Prepositions	1.7	3.2– 3.7	3.5	3.4– 4.3	3.9	4.4
Conjunctions	0.8	0.5– 1.8	0.9	2.3– 3.8	3.1	2.8
Interjections	5.0	1.1– 1.6	1.3	0.8– 2.0	1.1	1.1

The variety of words used increased markedly, being much the same number in each stage. The average number of times each word was used was 7.5 at 30 months; 4.9 to 4.6 at three and four; 3.2 with D and 2.8 with E at five, 2.9 with D at eight and 2.7 with E at ten, while the figure for the adults was 2.5. The small vocabulary and much repetition is reflected in the case of the baby, large vocabularies and absence of repetition in the case of the oldest subjects, while the little children were in an intermediate stage.

PARTS OF SPEECH OF THE TOTAL WORDS

In the parts of speech of the total words we find a much greater contrast between the early sentence stage

and the later stages than in the case of the different words. With the very little child nouns are of overwhelming importance, accounting for more than half of the words used, adjectives amounted to over a fifth, adverbs more than a tenth, while of pronouns, prepositions and conjunctions there was barely a trace.

If all the conversations are considered, we find nouns decreasing enormously, while verbs, pronouns, prepositions and conjunctions increase enormously. Adjectives decrease to a half, then increase slightly; adverbs increase somewhat, then drop again. In all the conversations but one from three years onward, verbs take the first place in point of numbers, with pronouns second and nouns third. The exception was H's conversation at three, where, because of her excessive use of "Mamma" which appeared in two-fifths of her sentences, nouns made up 24.6 per cent of her talk, verbs 23.5 and pronouns 18.6. In five of the eight conversations adjectives take fourth place, while in the others this is true of adverbs. The adult conversation differs little from that of the older children except in an increase in prepositions and conjunctions, and a slight decrease in pronouns.

Boyd (3) has made an exhaustive study of the development of sentence structure, having collected and analysed not only 1250 sentences of his daughter each year from the age of two to eight, but also 1800 conversational sentences from 18 English and American novelists. His daughter was precocious in talking, her average sentence length at the different ages being 3.3, 6.4, 6.9, 7.5, 7.7, 8.2, and 8.5 words. At two years her speech development was intermediate between the early and short sentence stages; from four years on the proportions of the parts of speech of her total words were remarkably stable.

TABLE 2

Percentages of the parts of speech of the total words

	EARLY SENTENCE	SHORT SENTENCE		ESTABLISHED SENTENCE		ADULT
		Range	Average	Range	Average	
Nouns	55.6	17.3–24.6	20.4	15.2–16.5	15.7	15.6
Verbs	5.0	23.1–29.0	25.4	24.7–30.7	28.1	20.3
Pronouns	1.7	18.6–23.1	21.1	19.4–24.0	21.5	18.8
Adjectives	21.3	7.6–15.0	10.6	10.2–16.5	12.7	11.8
Adverbs	11.4	13.3–18.6	15.3	10.0–13.2	11.2	11.0
Prepositions	0.5	2.5– 7.1	4.7	4.3– 8.8	6.1	9.1
Conjunctions	0.2	0.3– 1.9	1.0	2.0– 5.0	3.2	3.5
Interjections	3.4	0.5– 1.6	1.3	1.2– 2.0	1.6	0.8

In table 3 the percentages of the parts of speech of the total words are given for Prof. Boyd's daughter at eight and for the novelists whose sentence length ranged between ten and eleven words. (In the original there is one set of figures from male novelists and from another from female; in my table the two are averaged.) The results are also shown from hour con-

versations of 22 five year old pre-school children reported by Smith (8); the sentence length here averaged only 4.6 words.

The agreement of all the different tabulations is striking. Both of Prof. Boyd's lists show higher counts of adjectives and conjunctions than did my subjects. This may be due in part to a different grammatical interpretation. In an earlier paper by this author (2) possessive pronouns and nouns in apposition are classed as adjectives, whereas I considered the former pronouns, the latter nouns. Again a number of words in his list of conjunctions are not so classed by the Century Dictionary. The comparatively low proportion of verbs in the novelists' conversations perhaps reflects long and involved sentences.

TABLE 3

Percentages of the parts of speech of the total words in other studies

	SMITH'S CHILDREN AT 5	BOYD' DAUGHTER AT 8	THE NOVELISTS
Nouns	15 ±5	14.6	15.7
Verbs	27 ±6	28.3	24.3
Pronouns	25 ±6	18.4	17.6
Adjectives	17 ±8	15.2	16.4
Adverbs	11 ±4	10.2	9.4
Prepositions	6 ±3	7.7	9.1
Conjunctions	2.5 ±2	5.2	6.7
Interjections	2 ±2	0.3	0.8

TABLE 4

Numbers of each part of speech in average sentence

	EARLY SENTENCE	SHORT SENTENCE	ESTABLISHED SENTENCE	ADULT
Nouns	1.5	0.83	1.1	1.6
Verbs	0.16	1.02	2.1	2.5
Pronouns	0.05	0.87	1.5	1.6
Adjectives	0.6	0.4	0.86	1.1
Adverbs	0.3	0.56	0.8	1.0
Prepositions	0.02	0.2	0.5	0.8
Conjunctions	0.01	0.04	0.2	0.4
Interjections	0.1			
Total	2.7	4.0	7.1	9.0

ANALYSIS OF SENTENCES IN THE CONVERSATIONS

An analysis of the make up of the early, short and established sentences as used by my children in the sample conversations and also of the sentences of the adults is shown in table 4.

The characteristic of the early sen-

tence is a preponderance of nouns, and a lack of articles, auxiliary and copulative verbs, prepositions, and conjunctions; the same is true of the short sentence to a lesser degree. The established sentence is characterized by greater definiteness and complexity as is shown by the increased use of those relational words that were largely lacking before.

THE MOST USED WORDS

Which words are most used in conversation by little children, older children and adults? Schlag (7) believes that "Those ideas that are most effective and important in the childish soul will be expressed most often in his speech;" consequently he considers the tabulating of the words that are most used by children to be of prime importance.

Upon comparing the 10 words used most often in R's whole day conversation and in one hour we find that eight are the same, while the other two in the hour fall within the second ten of the day. The ten words used most often in the four different categories are shown in table 5.

The words of the baby are vivid and important ones. The little children show egotism, desire and dependence on parents, but the older children approximate the comparatively colorless speech of the adults.

In the first list there are only two words that appear in later lists—"Mamma" in the second list and "a" in all four. Six words appear in the three later lists—"I," "you," "it," "a," "that," "to." "My" and "want" are found with both in the small and older children, while the latter have "the" and "and" in common with the adults as well as the six words just mentioned.

Six of the little children's words occur in the nine most common words of Kindergarten children collected by Horn (4), while two more are to be found in the next seven. Eight of the ten most common words of the five to ten year children are identical with the eight most common words in this list.

TABLE 5

The most used words in the 900 word conversations with the average number of times each word was used in the sample

THE 2½ YEAR OLD		THE 3 TO 4 YEAR OLDS		THE 5 TO 10 YEAR OLDS		THE ADULTS	
Mamma	236	I	68	I	53	I	34
a	75	Mamma	44	is	26	to	33
there	38	it	22	it	24	you	32
gadda*	28	this	22	the	24	the	30
Thompson†	25	my	18	to	22	is	17
away	23	want	18	you	22	that	16
ran	20	a	17	that	17	it	15
hello	18	Daddy	16	a	17	have	13
horny	18	that	16	don't	14	of	12
toad	18	to	15	and	13	a	11

* A "universal word" for all objects whose names she could not or would not say.
† A neighbor.

Eight of the little children's words occur among the 14 most common of Smith's list (8), while eight of the older children and adults fall within the first twelve.

As to the Ayres (1) list of "The Thousand Commonest Words," the baby had one in the first ten, the little children four, the older children seven with two more in the next three, and the adults seven with three more in the next six.

The baby's speech is far more individualistic than that of the older children; there is little identity in the most common words at early ages. In seven all day conversations of children from 20 to 25 months the following words appeared in more than two records: "Mamma" in 6, "baby" in 5, Daddy, "dog," "shoe," "no," in 4, "look," "more," "nose," "there" in 3.

In all but two of the nine conversations "I" is the most used word; T did not use it at all, while H at three used "Mamma" a few more times. With D at three, R at four and five and E at five, "I" was used from twice to nearly three times as often as any other word, but with the two older children and the adults the use of "I" was not much different from that of several other words—"to," "you," "is," and "the." With the exception of H, the use of "I" decreased in general from a frequency of once in every 10 words with R at four to once in every 26 with the adult. The use of "you" increased with each age from 7 with H at three to 32 with the adult; i.e. H used "you" once in every 129 words, D at three once in every 60, E at five once in every 45, D at eight once in every 39, E at ten once in every 31 and the adults once in every 28 words. Thus we see pictured the gradual development of the little egoist into a social being.

Schlag's hypothesis fits the case of the very little child, but is no longer true by the time language is well established. Schlag gives the results of two sets of data which he collected as a nucleus for his desired "Häufigskeitswörterbuch der Kindersprache." He recorded 11270 words in sentences of a six year old girl; those most used were: ich (542 times), die (416), das (405), der (270), mal (207), ist (188), da (180), hier (180), so (174), du (135), ach (129). The most common words among 12078 collected from several eight year old children were: ich (694), different forms of haben (549), der (390), die (356), das (353), da (311), ist (246), nicht (237).

The words of the older children are much less concrete and vivid than those of the little ones. Instead of nouns they learn to use pronouns, instead of gestures they employ prepositions. There is less of emotion and more of intellectual content as speech develops, and what is lost in picturesqueness is gained in clarity and in the ability to draw fine distinctions.

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Bi-lateral Transfer in the Motor Learning of Young Children and Adults[1]

ELLA L. WIEG

INTRODUCTION

THE large amount of experimentation and the vast range of discussion which have centered about the general problem of learning during the last decade indicate how rapidly interest in this field has mounted. This increased interest has not only widened the scope of problems but has stimulated interest in older and more original phases. One of the most vital and far-reaching of these problems is the effect of training on subsequent habit formation. This effect may be either positive or negative. Instances of the former are spoken of as habit transfer, and those of the latter as habit interference.

It has long been known that practice of one limb in the performance of a skilled act increases the ability of the bilaterally symmetrical part in the same act. This phenomenon has been termed cross-education.

Interest in this phase of the problem dates back to the middle of the nineteenth century when Weber (104) observed that his son, who had been taught to write with the right hand, became a spontaneous mirror writer. At the same time, Fechner (5), with whom Weber had corresponded concerning this phenomenon, made similar observations. He found that training of the limbs on one side of the body appeared to be shared by those on the other side. Simultaneously, in 1858, Volkman (20) reported an investigation in a related field. In training for tactile impressions of distance discrimination he found the idle hand sharing the gain. A more elaborate experiment, set up by Woodworth (23) in 1890, measured the accuracy of voluntary movements. He reported transfer effects from left to right and the reverse when the drawing of straight lines was practiced. He made special note of the relationship obtained between speed and accuracy. As speed increased ten-fold, errors increased six-fold.

Two years later, Bryan (2) reported similar results on an investigation in which he tested tapping ability of children at different age levels. He found crossed fatigue effects independent of body fatigue. In every instance measurable transfer from the right to the left side of the body was obtained. Further, he observed that, although in general the right hand reaction was superior to the left hand, at certain ages the left excelled.

Scripture (18), in 1894, devised an experiment to show the transfer from right hand to left hand in the ability

[1] From the Institute of Child Welfare, University of Minnesota.

to thrust a needle into a small hole. He found a 26 per cent improvement of the left hand after practicing the right hand. Davis (3), four years later completed a study in tapping in which he practiced both hands and feet. He reported definite transfer effects occurring between bi-laterally symmetrical parts, and indicated transfer to parts not symmetrical. The transfer gain was found to be greatest for the right foot, and the relative gain was greater for the feet than for the hands. For accuracy in target shooting he calculated a relative gain of .51 for the right side, and .36 for the left side, thus indicating right side superiority.

In 1900 Wissler and Richardson (22) reported large amounts of transfer for the unused hand in the use of a dynomometer, Swift (19), in 1903, found for his juggling experiments that training of the right hand was always transferred to the left. Wallin, in 1910 found the same condition to hold for the eye when training in perspective for one eye gave positive transfer effects for the other. In the same year Starch reported a mirror drawing study in which he found that during one-hundred trials of practice the idle hand improved 83 per cent in speed and accuracy, while over a fifty trial period the improvement for the idle hand was 65 per cent.

A study of transfer and retroaction, in which 4 pencil mazes were used, was carried out by Webb in 1917. He reported transfer effects in all cases, and gave special emphasis to the fact that the transfer was not uniformally great, but was a function of the first problem and of the direction of transfer.

About ten years later, in 1921, Norcross (14) attacked the problem with the specific purpose of isolating the common elements in motor learning. By practicing his subjects in inserting numbers into an adding machine, he found a correlation of +.11 between speed and accuracy, and a speed gain of 16.67 per cent by the idle hand in contrast with a 13.67 per cent improvement with practice. In the same year Lavin found in his own experiment that the subjects could, after having learned a maze pattern with one hand, reproduce its form with the other hand, and with the head as well.

Ewert (4), as recently as 1926, was the first to use a control group in the work on cross-education. Previous investigators had not taken into account the effect produced by a single trial for the hand or foot with which a transfer trial was later taken. In his mirror drawing practice Ewert found the non-preferred hand improved thirty-six per cent in time, and 21 per cent in accuracy during fifty trials. Transfer proved to be greater from the preferred to the non-preferred hand than the reverse, while the relative ability to improve was about equal for the 2 hands.

In 1928 Bray (1) examined transfer to body members not bilaterally symmetrical. He practiced skill in hitting a target seen in a mirror, and found transfer amounting to approximately six trials taking place from right hand to right foot. Less transfer occurred from right foot to right hand, but it was effective over a longer period of time. Beeby in 1930 investigated the organization of simultaneous constituents of a continuous

training skill. Both positive transfer and interference were found in the transfer from single to double-handed practice. Further, he found that the same amount of transfer occurred in the change from single to double-handed practice as from hand to hand. He concluded—". . . . that transfer is general rather than specific."

Early theories

With a single exception the studies just summarized agree to answer in the affirmative the question "Does transfer occur in motor learning?" Another question, but one showing less uniformity of opinion is that of the amount of such transfer, and the agency through which it operates. What the factors are that make transfer possible, is a question that awaits further investigation as the following review will show. The earliest workers explained the phenomenon in terms of the educational theory of formal discipline. Davis (3) spoke of ". . . . the education of attention and will power through physical training." He explained the greater degree of transfer obtained for symmetrical, and closely related parts as due to ". . . . close connection between different parts of the muscular system, through nervous means—being closer in parts related in function or position." Scripture (18) as well subscribes to the theory of formal discipline when he says ". . . . physiologically speaking, that the development of the centers govering a particular muscle causes at the same time the development of higher centers concerned with groups of muscles. Psychologically speaking, development of will power as a whole."

Current theories

As experimental evidence accumulated, the functional theory proved inadequate to account for the facts of transfer as found, and two rather distinctly opposing theories developed. One general formula—the theory of identical elements—has been proposed by Thorndike. In his Briefer Course of Educational Psychology he says ". . . . there are bonds involving situations and elements of situations which are, in the ordinary sense of the word general." These identical elements, he explains, may include specific movements, attitudes, and reactions constituting information or subject matter, or more general adjustments of an emotional, motor or mental nature. But, he says that such reactions carried over are often not consciously identified or appreciated.

In marked contrast with the followers of Thorndike stands the group that insists upon the conscious emphasis of the generalization of methods, ideals, attitudes, etc. Then there are still those who are unwilling to abide by either theory as being sufficient, but believe that both agencies must function, and that neither can stand alone in explanation. Some have expressed the belief in a spread of muscle impulse. This group feels that transfer is, to a degree at least, the result of common head, trunk, and eye movements involved, so that the apparently idle muscles are really being exercised. Davis (3) and Woodworth (23) support this view, while Wissler and Richardson (22) speak of ". . . . diffusion of motor impulses" as giving rise to transfer effects.

Swift (19) concludes that for his ball tossing experiments the conscious acquisition of method, plus the direct effect of training upon the symmetrical portions of the nervous system explains the results obtained. On the other hand, to quote Webb—"Rational elements are present in humans, but it is recognized that these ideational activities function with little effectiveness in the mastery of the problem."

Norcross (14), who attempted to single out identical elements concludes that (1) general habits and conditions improve; (2) emotional set is perhaps somewhat of a factor; (3) higher centers are concerned. Lavin (54) feels that his own study shows that muscle joints, and tendon sensations, and sensations of cutaneous origin were factors. But, he states, that some spatial scheme was developed, and expressed in terms other than through local motor sensations, was equally apparent. He found, for instance, that watching others make the movement was more effective as a method of teaching than the mere performance of the act by the subject.

Pear (16), in his discussion of "The Nature of Skill" differentiates between "intension" and "extension." He says "Altho transfer resulting from, and merely due to exercise of any particular function . . . . ." is rare, he believes that transfer ". . . . resulting from extension of attitudes, sentiments, ideals and knowledge of methods . . . ." can occur. In referring to the conclusions of Langdon and Yates (10) he says that since low grade skills require minimal attention, transfer ". . . . might not be expected between this 'insulated entity' and the rest of the personality."

Similarly Bray says "The explanation lies, in part at least, in transfer of methods, which having been learned for one part of the body, are carried over to practice with another part. More familiarity of setting is also probably important." Beeby, in his report speaks of the subjects as saying they "let the arm swim," and he therefore concludes that, although the focality of consciousness is the essence of the "learning stage," later practice is best in a ". . . . vague, uniform, even slightly dazed state of mind."

Scott, working with the stylus maze also recorded subjective reactions. He found his subjects unaware of the reason for doing a thing. They expressed the feeling as a motor "impulse to go—thus causing the pattern to function non-consciously." Even when only a few errors were made his subjects often failed to recognize the pattern. Further, he states that recognition usually came suddenly. This finding is in harmony with Wheeler's statement when he says "Transfer is not dependent upon common elements, for there are no common elements from the standpoint of organismic physiology. Rather, it is a case of falling under the third organic principle, namely, the whole governs the activities of its parts."

McGeoch and Oberschlap, who find an increase in the ease of learning the six-and-twelve-letter problem as a result of practice at one another, and at the eighteen-letter-problem conclude —"Transfer to the eighteen-letter problem does not occur consistently.

A possible explanation of the latter fact is that transfer is a function of the amount of the preceding practice, measured in actual learning effort. On this assumption one would expect less transfer from the shorter to the longer problems."

This review indicates rather clearly that, despite the long continued investigation, the problem of cross-education is in need of more research. The present study was undertaken with the hope of throwing further light on the existing theories of transfer; first, by means of measuring the transfer effects for hands and feet in the serial motor learning of young children; and second, by comparing this performance with the performance of adults on the same learning problem. By throwing into relief the cumulative effects of the relatively long period of general practice enjoyed by adults, such comparative data should indicate whether transfer is determined by specific or general training.

Aside from serving these more immediate aims, data of this study lend themselves readily to an analysis of error elimination, since the maze used presented homogeneous units in all respects except that of the relative direction of culs-de-sac.

METHOD

Subjects

A total of 44 children, 24 boys and 20 girls were used in the experiment. Ages ranged from sixty-six months to seventy-eight months. The children were obtained from the first grade of a parochial school; first grade and kindergarten of a city school; and the kindergarten of the Institute of Child Welfare; all in the city of Minneapolis. In addition to the 44 children, 17 adult subjects were used. These were drawn from the graduate students and clerical staff of the Institute of Child Welfare.

A single group of cases provided both the experimental and the control subjects. To accomplish this, the total number of children was grouped in "sets" of fours, so as to obtain, as nearly as was possible, an equated "set" made up of a right hand, a left hand, a right foot and a left foot learner. Thus each subject was given a three fold matched control. Matching was based on I. Q., C. A., socio-economic status, sex, and maze learning ability. No effort was made to equate adult groups.

"Sets" were kept approximately within a range of 20 points in I. Q., 3 months in C. A.; 3 occupational classes (based on the Minnesota Scale); same sex; and matched as closely as was possible in maze learning ability.

Apparatus

The lack of an instrument for serial learning suitable for both hand and foot action made the development of new apparatus necessary. In devising this, several essentials were kept in mind.

(1) To reduce the time element to the lowest possible limits since experimentation in learning with young children is difficult at best.

(2) To make the problem sufficiently difficult so as to provide differentiating possibilities.

(3) To reduce intrinsic variations of the problem to a minimum.

(4) To obtain an instrument showing acceptably high *reliability*.

(5) To provide an apparatus making possible a comparative study of child and adult.

Husband's (9) work, which supported the conclusions of Miles (13) and Nyswander (15) by demonstrating that his subjects took 16.7 trials to learn the same pattern in the high relief finger maze that took Warden's (21) subjects 69.4 trials with the stylus maze, suggested that a maze affording cutaneous contact would best satisfy essential No. 1. The T type of cul-de-sac, shown by Nyswander and Stone (15) to give satisfactory reliability, was selected.

To insure higher reliability *adaptation trials* were given on a maze constructed of similar materials, but very different in pattern.

Unity of the problem was maintained to the greatest possible degree by using a single type of cul-de-sac; making all connecting paths of equal length; following every true path with an equal length of cul-de-sac; and making the two bi-lateral halves comparable in the number of culs-de-sac used—thus giving the same number of culs-de-sac on each side of the midline of the body.

Since by preliminary experimentation the standard type of blindfold—described by Miles (13) and others—was found disconcerting for both children and adults, the screen method was used instead.

Figure 1 shows the mazes used. The rounded grooved paths were constructed from sheet metal having soldered mitre joints at the turns. The total pattern was then soldered to a wood base, one inch thick, covered with sheet metal. The finger grooves, one-half inch wide, and about one-quarter inch deep, had a main arm of the T two inches long, a cross bar two inches long, whereas all connecting paths were four inches long. Thus every true path was followed by a cul-de-sac of equal length.

Only forward-going culs-de-sac were used. Since the length of path units was kept uniform, and the same avoidance reaction pattern was presented by each blind, the mazes provided, theoretically speaking, perfect homogeneity.

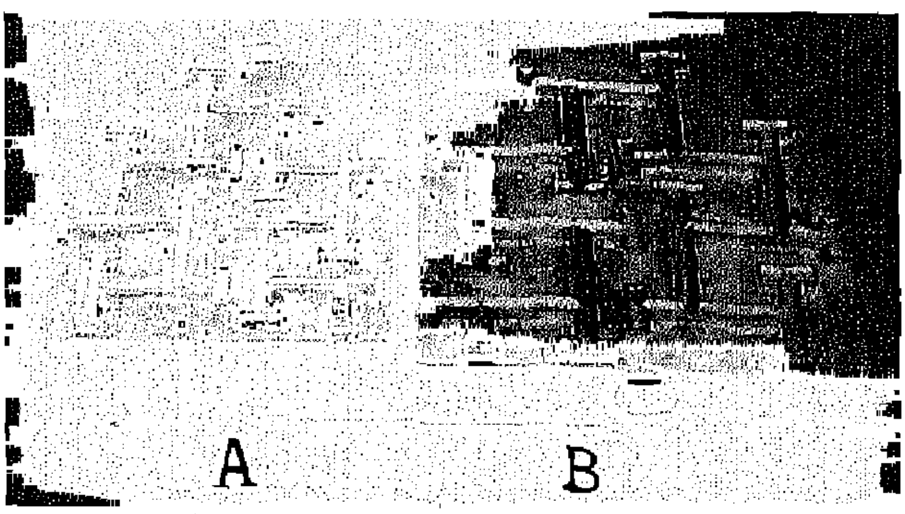

FIG. 1

Procedure

For adaptation trials all subjects were given 3 successive trials with each hand and each foot, for two days.

For finger learning the maze was placed on an ordinary card table with the cloth screen shown in figure 3 covering it. The cloth was mounted on a metal frame 18 inches square and 11 inches high.

Figure 2 shows the same from the experimenter's position. Figure 4 shows a revolving chair, adjustable to the height of the individual child. For foot learning the toe maze was placed on the floor, directly under the table, a cloth cover remaining over the pattern until practice began.

Three successive practice trials were given daily until the subject satisfied the criterion for "complete learning," which was defined to mean not more than two errors in three successive trials. To avoid the possibility of over-fatigue and impatience, no more than ten minutes were allowed for each trial, and if the goal was not reached within this ten minute period the trial was called a failure. Six of the 54 initial trials proved failures. In the early stages toe learners frequently, and finger learners occasionally, showed symptoms of fatigue long before the ten minute period expired. To overcome this the subject was given a relaxation period whenever the re-

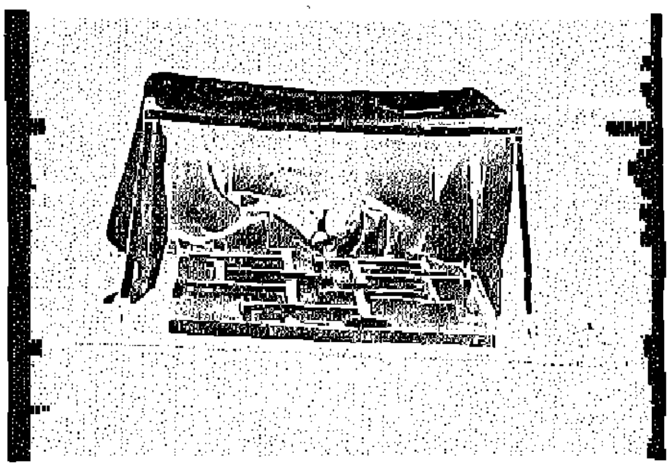

FIG. 2

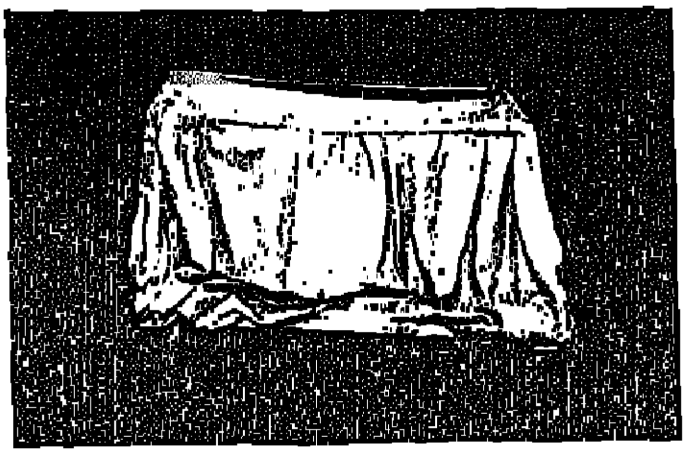

FIG. 3

quest was made; sometimes the rest had to be suggested by the experimenter as fatigue became evident.

The problem of proper motivation was considered to be one of vital importance. An attempt to keep this uniform for the whole experiment proved futile because the motivating power of an incentive varied greatly from group to group. While the subjects from one school worked zealously for score improvement in anticipation of carrying away with them a Dennison seal, those from the other schools considered this as somewhat of an insult. Since interest and effort of the subjects were of vital importance, the incentives were selected to meet the needs of each group.

Rewards—if such they may be called—were given regardless of the degree of success or failure; effort rather than score was applauded. The major portion of the directions was given when the adaptation trials were taken. The subject was seated before the maze and, being shown a sample piece (composed of a true path and a T), was given the following directions:

"This game is played by running the fingers in a path like this. The path under this cover is long and has many turns like a road. The trick is to find the sand paper post at the end of the road. The road begins here (finger placed on the beginning post), and at the end is another post like this, but covered with sandpaper. Some turns in the road take you the right way, and some take you the wrong way. Some take you to an end like this. When you come to an end, you must back up, and find a road that takes you where you want to go. (Subject was asked to run the finger in the sample groove). Do you feel how the

FIG. 4

turns sometimes come on one side of the road and sometimes on the other? Then you must be sure to feel both sides with your fingers. When your hand gets tired we will rest. When I say 'Ready, go' you start your finger to find the sandpaper. You may go just as fast as you like, but be sure to go carefully so you feel both sides of the path."

The index finger was placed on the starting point, and the other fingers were curled under so as to discourage the exploration of the paths in the adjoining section. When the toe trials were begun, the following directions were added: "Your big toe is going to do just what your finger did. Try it on this little piece. Be sure to feel both sides of the path."

When learning proper was begun the following directions were added: "This is a new game. It has a road just like the other game; but the road has many more turns. You'll find a sandpaper post at the end." For finger learning, a sample of the narrow path was presented, and the subject was allowed to run the finger along the groove.

In the early stages three-minute relaxation periods were allowed between trials. Later, the subject decided for himself the time needed for rest. Although conversation was discouraged, three "stock" phrases were used to assure attention when there was evidence of "wandering." These phrases were:

(1) "Your finger (toe) knows just how to go along this road."

(2) "You have a fine finger (toe): it feels both sides of the path."

(3) "You are always thinking about finding the sandpaper, aren't you?"

Running records were taken of the finger and toe reactions. All true paths were lettered, the main arms of the T were numbered and the two halves of the bar of the T culs-de-sac were recorded in symbols. Time for each trial was recorded by means of a stop watch.

Each set of 4 equated subjects composed a unit which remained constant both for learning and for transfer measures. Subject No. 1 of each set learned with the right hand; subject No. 2 with the left hand; subject No. 3 with the right foot; and subject No. 4 with the left foot. Five of the ten sets learned the true pattern, and five sets learned its mirror image. By matching the subjects in each set (on the basis of the criteria mentioned on page 251) it was possible to get control scores for hands and feet (hereafter spoken of as "members") within the experimental group. The mean of initial trial scores for each hand and foot gave the control score from which transfer was measured. This eliminated the troublesome problem of evaluating the differences in adjustment between the control and the experimental subjects. It also afforded for every learning member a control measure when the toe or finger had no subsequent trial.

In obtaining transfer measures, as many variations were used as the small number of subjects permitted.

(1) *Transfer from one pattern to its opposite* (making two variations).

(2) Bi-lateral transfer (hand to hand or foot to foot).

(3) Transfer to the same side of the body (hand to foot or foot to hand).

This afforded five sets for each of the four transfer variations.

With the adult subjects an additional variation was introduced, a measure of "diagonal relationships" (right hand to left foot) being obtained. The RH to RF as well as the RF to LF direction was omitted.

reliability of the combined scores for all members and for both patterns was computed, the Pearson Product Moment formula being used in this instance. In the case of the adults, only the combined scores were used, since the number of cases was so small. Here the number of trials had to be limited to 6 because hand learning was completed in 2 days by one subject.

TABLE 1

Odd-even reliability based on time and error scores

(a) Children and (b) Adults

TRIALS	MEMBER	NUMBER	RANK ORDER "Stepped up" Time	RANK ORDER "Stepped up" Error
(a) Children				
4–9	RH	11	.94	.96
4–9	LH	11	.97	.98
4–9	RF	11	.89	.92
4–9	LF	11	.72	.66
			True pattern	
4–9	All	22	.96	96
1–8	All	10	.98	.96
			Mirror image	
4–9	All	22	.90	.91
1–8	All	18	.96	.93
(b) Adults				
1–6	All	17	.96	.84

Reliability

Reliability coefficients were computed, for time and error scores, by the odd-even method on 44 children and 17 adults.

Spearman rank order coefficients were obtained for each hand and each foot separately, and again for each pattern separately. In these cases the "Spearman-Brown Prophecy formula" was applied. In addition, the

Table 1 gives the results for children and adults for both time and error scores.

Reliability is found to be higher for hands, when compared with feet, on both time and error scores. No definite superiority for either side of the body is indicated by this table. When reliability for time is compared with

that for error, time is found a more reliable measure for three members, while the RH shows slightly higher reliability for error scores.

These coefficients are rather higher than those commonly obtained for maze learning. Two possible explanations are suggested. First, in the construction of the instrument, every possible effort was made to incorporate elements which have by previous experimentation proved to yield high reliability. Here are included the T type of cul-de-sac used by Stone and the idea of cutaneous contact developed by Miles (9) and Husband. Second, 2 days of adaptation trials were provided. This unquestionably aided in better adjustment to the situation as a whole when practice began, and tended to make performance on the real problem more stable.

RESULTS

Learning

Initial records for accuracy show children making the smallest mean number of errors with the left hand, and the largest number with the right hand. (See table 2.) The two feet show practically like degrees of accuracy, and take positions between the two extremes of the hands. The same statements hold for adults.

Adults make more mean initial errors than do children with each of the four learning members. Adults show greater range than children for all body members, and greater relative variability for the RH, the LH, and the LF.

TABLE 2

Means and range based on initial error scores for 40 children and 17 adults; also the percentage ratio between the scores of children and adults

		Mean number of errors	Variability		Ratio Child/Adult
			Range	C of V	
RH	Children	36.2	61	53.81	.49
	Adults	73.6	101	56.25	
LH	Children	23.1	53	69.27	.84
	Adults	28.5	85	103.57	
RF	Children	29.4	38	37.65	.44
	Adults	66.8	168	27.97	
LF	Children	30.1	36	44.18	.54
	Adults	56.0	120	110.02	

Comparison of the limb-to-limb performance of the two age groups shows children with the smaller variation from hand to hand. The left hands of the two groups tend to approximate each other more closely than do any other two limbs.

Comparison of adults and children

For initial speed as measured in inches traveled per second of time adults obtain higher scores than children for each of the four learning members. The data are presented in

table 3. Adults make the greatest speed with the RH, whereas children show the greatest speed with the LH. For adults the LF is superior to the RF, and for children the reverse is true. This shows for both age groups the cross-relationships; the order from highest to lowest mean initial speed for children is LH, RH, RF, LF. For adults the order runs: RH, LH, LF, RF.

Both age groups show the LH to be most variable in its performance. Initial speed records show children with greater absolute variability than adults for all members except the LH. Adults show the greatest divergence between performances of the RH and RF, whereas children show the largest difference between scores for the LH and the LF.

For both age groups, performances of RH and LH show greatest similarity. The scores for RF and LF come second in order of likeness while the comparison between the performance of hands and feet shows the greatest dissimilarity for both children and adults.

TABLE 3

Means, S.D.'s, σ M, and range for initial speed scores of 40 children and 17 adults

	M		S.D.		σM		RANGE	
	Child	Adult	Child	Adult	Child	Adult	Child	Adult
RH	.567	1.175	.15	.07	.05	.07	.51	.20
LH	.720	.998	.23	.21	.07	.21	.86	1.54
RF	.364	.673	.13	.00	.04	.00	.50	.40
LF	.327	.771	.15	.08	.05	.08	.50	.30

Comparison of speed and accuracy

Comparison of speed and accuracy records within each age group shows children with the best speed and accuracy record for the LH, and the second best speed and poorest accuracy record for the RH. Adults made the best speed and the poorest accuracy record with the RH, and the second best speed and the best accuracy record with the left hand. For both groups the foot of greater speed is the more accurate. Thus an inverse relationship between speed and accuracy is obtained for the RH.

Practice effects

Practice carried out to meet the criterion set for complete learning, shows different effects for the four limbs and for the two age groups. (See table 4.) Certain effects, however, are constant for both age groups. Absolute variability increases with practice for children and adults alike. Both groups show the RF with the largest percentage increase over initial speed score, and both groups show the difference between RH and LH final speed scores to be the smallest when a limb-to-limb comparison is made. Both groups take the order of LH, RH, RF, LF when members are ranked in order from the highest to the lowest final speed scores. (This is the order held by children on initial status also.)

Practice shows differentiating effects for the two groups and for hands and feet in several instances. Adults, who showed the lesser absolute variability on initial status, are more variable (absolute) than children on final trials. Adults have also become more variable relatively for the RH, LH, and RF, while children remain more variable (relative) with the LF.

Adults show larger mean final speed scores than children for both hands and feet. Both groups show the RF making the greatest progress through practice. Adults show the smallest advantage over initial speed scores with the RH, and children with the LH. (The hand of greatest initial speed showing the smallest percentage of advantage for both groups.) The capacity for gain (measured in terms of percentage of advantage over initial scores) is more uniform for adults than for children when a limb-to-limb comparison is made.

TABLE 4

Data for initial speed, final speed, absolute gain, percentage ratios, absolute and relative variability for 40 children, and 17 adults

		Speed		Gain		Variability			
						Absolute		C of V	
		Initial	Final	Absolute	Per cent ratio	Initial	Final	Initial	Final
RH	Children	0.577	1.831	1.27	322.9	0.51	1.01	26.1	19.6
	Adults	1.175	2.891	1.72	246.0	0.20	1.21	5.9	29.4
LH	Children	0.720	1.065	1.25	272.9	0.86	0.93	31.6	18.3
	Adults	0.995	3.026	2.05	305.2	1.54	2.77	21.0	30.0
RF	Children	0.364	1.551	1.19	426.0	0.50	0.70	36.5	14.8
	Adults	0.573	2.231	1.66	389.1	0.49	2.10	15.7	33.1
LF	Children	0.337	0.938	0.61	286.8	0.50	0.88	45.2	39.4
	Adults	0.771	2.01	1.24	260.7	0.30	1.31	10.3	26.3

Trials taken for learning

The number of trials taken for complete learning—in other words the effect of practice upon accuracy—again shows differences in efficiency between the groups and also between hands and feet. For children a ranking of limbs on the basis of the number of initial errors made results in the order of: LH, RF, LF, RH. When limbs are ranked on the basis of the number of trials taken, the order is: LH, RH, RF, LF. When ranking is based on the relative progress made in accuracy, the order is: RH, LH, RF, LF.

This indicates that for children hands have greater capacity for gain than do feet, and that the right side gains more than the left side.

For adults the ranking of limbs on the basis of initial errors yields the following order: LH, LF, RF, RH. Ranked on the basis of the number of trials taken for learning gives the order

of: RH, LH, LF, RF. Ranked on the basis of relative progress made in accuracy shows the order of: LH, LF, RF, RH. In terms of capacity for gain in accuracy, this indicates a left side superiority with the hands taking the extreme positions. For adults, the number of initial errors appears to parallel the capacity for improvement in accuracy, but for children no such relationship is apparent.

Adults show greater limb-to-limb variation for capacity to improve in accuracy than do children.

A comparison of the two age groups for the four learning measures used, namely: initial speed, initial error, final speed, and the number of trials taken for learning, shows the two groups most nearly alike in initial speed, and most widely different in the number of trials taken for learning. Since adults made more initial errors than children, this difference in capacity for improvement in accuracy becomes even more striking.

Transfer

The speed and error scores for transfer are given in table 5. Transfer speed scores show for children positive effects for seven of the directions used, and negative effects for one. For accuracy the initial error scores are reduced for six of the directions used, and increased for two. For both speed and accuracy the poorest transfer scores are made for the H-to-F directions.

Adults show positive transfer effects for both speed and accuracy for each of the eight directions used. They show the best speed transfer scores when going from a RH learning to a LH transfer trial, whereas children show their best mean score for the RF to RH direction. (In each case the hand of greatest initial speed obtained the best transfer speed score.)

TABLE 5

Mean transfer scores for children and adults based on mean speed and error scores

LEARNING LIMB	TRANSFER LIMB	CHILDREN		ADULTS	
		Speed	Errors	Speed	Errors
RH	LH	0.96	5.2	2.77	0.0
LH	RH	1.25	2.71	2.54	0.07
LH	LF	0.35	37.0	0.57	2.0
RF	LF	0.55	6.16	1.73	0.0
RF	RH	1.43	5.25	2.11	1.0
LF	LH	0.99	0.5	2.07	0.0

Adults show the poorest mean score for the LH to LF direction, and children make lowest score for the RH to RF direction. (In each case the lowest transfer score was obtained when the hand of highest initial speed was placed in the *learning* position.)

For both age groups transfer results for speed are always better when going in the direction from the less efficient to the more efficient limb (efficiency being based on initial and final speed scores). For accuracy the same tendency is shown—transfer scores showing the higher accuracy when going

from the less accurate to the more accurate member (as based on initial error scores). When learning members are held constant, and transfer members vary, the better transfer score is obtained for the member showing greater efficiency on initial status. When transfer members are held constant, and learning members vary, the better effect is obtained for the learning member having the smaller initial speed score.

For the H-to-H transfer both groups show the better score when the hand of better initial speed is in the transfer position. For bi-lateral foot transfer both groups show the better effect when going from RF learning to LF transfer.

When transfer measures are based on accuracy, adults show perfect trials for the RH to LH, RF to LH, and the LF to RH direction, while children show the smallest mean error score for the LF to LH direction. For both age groups, hands placed in the transfer position obtain better transfer accuracy scores than do feet in this position. Again, for both groups the hand making the best initial accuracy record obtains the best transfer score.

Children make the poorest transfer record for accuracy when going from LH learning to LF transfer, while adults make their poorest record for the RH to LF direction. In both cases the LF shows the poorest transfer measure for accuracy.

Pattern variation

The four transfer situations used, namely: (1) transfer to the same pattern and the same side of the body as used in learning, (2) transfer to the opposite pattern and the opposite side of the body from that used in learning, (3) transfer to the same pattern but the opposite side of the body from that used in learning and (4) transfer to the opposite pattern but the same side of the body as used in learning show markedly different effects as based on speed and accuracy, as will be seen from table 6. The lowest speed and the greatest accuracy records were obtained when the transfer trial was taken on the *opposite pattern* and with the *opposite side* of the body from that used for learning. The highest speed, and the poorest accuracy scores were made when the transfer trial was taken on the *same pattern* and the *same side* of the body as used in learning. Situations three and four take the intermediate positions and obtain practically identical results.

TABLE 6

Mean transfer speed and error scores for children grouped on basis of 4 different transfer situations

SITUATION	M SCORES	
	Speed	Error
1. Same pattern and same side of body..........	1.808	20.2
2. Same pattern and opposite side of body......	0.932	7.0
3. Same side of body and opposite pattern......	0.875	7.6
4. Opposite side of body and opposite pattern..	0.801	5.61

Sex differences

Analysis of children's data on the basis of sex and age shows small and inconsistent differences.

Inter-correlations

Intercorrelations between the variables of *initial speed, final speed, initial error, number of trials taken for learning, I. Q.*, and *transfer scores* yield coefficients of very low order, ranging from $.51 \pm .11$ between initial speed and I. Q. to $-.02 \pm .09$ between transfer speed and I. Q. The correlation between the number of trials taken for learning and initial error is $.38 - .09$ indicating a tendency for subjects making the highest initial errors to take more trials for learning.

Error elimination

An analysis was made of the frequency with which individual culs-de-sac were entered, and also of the total number of retracing and cul-de-sac entrance errors for each of the two bilateral halves of the maze separately. No consistent sex or age differences for children were found on this basis.

For both age groups more errors are made on the first half of the maze pattern regardless of whether the true pattern or its mirror image is learned. The data are given in table 7. In terms of overlapping, 33 per cent of the cases reached or exceeded in the tracing of the second half of the maze the number of errors made on the first half. In terms of retracing errors, the second half of the pattern showed less than fifty per cent of the total retracing errors made on the first half of the pattern.

TABLE 7

Total errors for the two bi-lateral halves of the maze patterns for boys and girls; for true pattern and mirror image; for "own" and "opposite" side learning, and totals for each type of error

	FIRST HALF	SECOND HALF	TOTAL
Boys	4,410	3,151	7,561
Girls	4,623	2,980	7,603
Own Side	4,389	3,502	7,891
Opposite Side	4,644	2,629	7,273
True Pattern	5,425	3,851	9,276
Mirror Pattern	3,608	2,280	5,888
Three Error Types:			
Retracing	2,409	1,032	3,441
Stem of T	2,966	2,225	5,191
Bar of T	3,658	2,874	6,532
Total Errors	9,033	6,131	15,164

In the analysis of the frequency of culs-de-sac entrance certain blinds show definitely higher frequencies than do others. This holds for the true pattern and the mirror image alike. For the individual culs-de-sac leading in the horizontal direction, frequency of entrance does not prove to be a matter of right or left direction as such. Analysis of the data for children shows the six most frequently entered culs-de-sac to lead more nearly in the goal direction than do the true paths immediately following. The three blinds

showing highest frequency of entrance lie within the first half of the pattern; the second group of three, showing high entrance frequencies, lie in the second half of the pattern. These statements hold for the analysis of adult data with one exception. Cul-de-sac No. 1, which represents the less direct route to the goal, is included in the group of three culs-de-sac most frequently entered, and the difficulty it presents cannot be explained in terms of "goal-direction."

TABLE 8

Means of transfer scores based on speed and error scores for children

	LEARNING MEMBER	TRANSFER					
		First limb		Second limb		Third Limb	
		Speed	Error	Speed	Error	Speed	Error
1	RH	.96 LH	5.2	.33 LF	36.0	.43 RF	30.8
2		.32 RF	51.4	1.39 LH	1.25	.42 LF	43.0
3	LH	1.25 RH	2.71	.37 RF	3 fail	.28 LF	3 fail
4		.35 LF	37.0	1.18 RH	3.3	.34 RF	3 fail
5	RF	.55 LF	6.16	1.18 LH	3.0	1.22 RH	2.5
6		1.43 RH	5.25	.85 LF	2.0	1.46 LH	1.5
7	LF	.56 RF	7.83	.90 RH	3.1	1.11 LH	2.2
8		.99 LH	0.5	.59 RF	13.0	1.37 RH	1.5

Position of limbs in the transfer sequence

Although the small number of adult cases prohibited an analysis of second and third idle limb transfer measures, such analysis was made for children. In the latter case each of the idle limbs was given a transfer trial following the sequence given under *method*. See table 8. The position of a transfer member in the sequence—that is its being the first, or the second or the third limb to produce the tracing—had no apparent significance except that the foot failed more frequently when in the second or third position. For speed scores the RF in the learning position shows the best results for each of the idle limbs regardless of whether the transfer limb is the first, or the second, or the third member to take a trial. For accuracy the LF and RH in the learning positions produce the best effects for transfer members—the LF learning showing the best results for the RH and RF, and the RH learning giving the best transfer score for the LH and LF.

Transfer scores equated

An attempt was made to ascertain the transfer effects when the initial scores of the four limbs are identical. (See table 9 and figures 5 and 6.) Because of the large number of foot failures this procedure could be applied to speed scores only. For this purpose the constant speed score of one inch per second of time was established.

Having obtained the factor that would reduce the initial of each limb to the same factors. This procedure was carried out first to show results when

TABLE 9

Transfer speed and error scores grouped to show differences when learning and when transfer members are held constant

(1) LEARNING MEMBER CONSTANT			(2) TRANSFER MEMBER CONSTANT		
	Speed	Error		Speed	Error
RH to LH	.06	5.2	LH to RH	1.25	2.71
RH to RF	.32	51.4	RF to RH	1.43	5.25
LH to RH	1.25	2.71	RH to LH	.96	5.2
LH to LF	.35	37.0	LF to LH	.09	00.5
RF to LF	.56	6.16	RH to RF	.32	51.4
RF to RH	1.43	5.25	LF to RF	.56	7.83
LF to RF	.56	7.83	LH to LF	.35	37.0
LF to LH	.09	0.5	RF to LF	.55	6.16

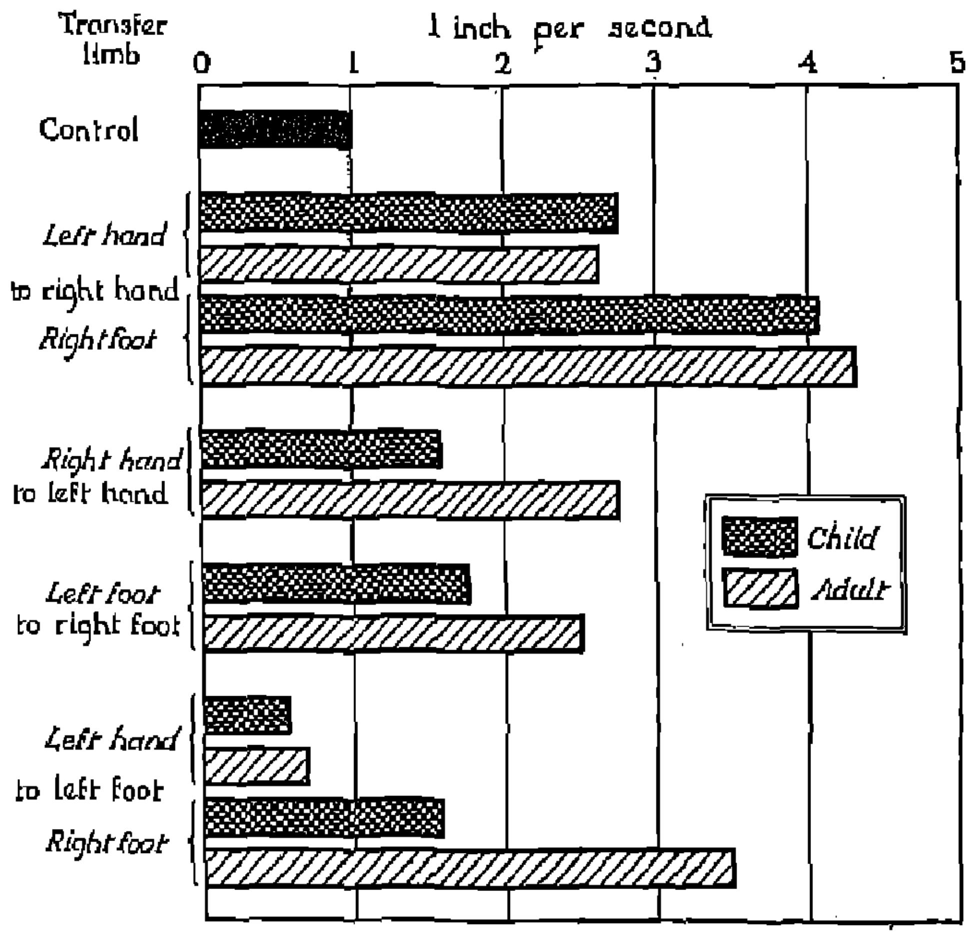

FIG. 5. FIRST TRANSFER SPEED SCORES FOR CHILDREN AND ADULTS EQUATED TO A COMMON SCORE FOR THE LEARNING LIMB. (TRANSFER LIMB HELD CONSTANT)

constant score of 1.0, the respective transfer scores were multiplied by the same initial scores, and second when all *learning* members were given the

all members in the *transfer* position were given the same initial score. This procedure doubtlessly has its limitations since the number of cases used is so small, but an interesting difference appears between results obtained. When the transfer members are given the same initial speed score, but scores for learning members vary, the transfer scores obtained by each hand and foot are remarkably more constant than is true when all learning members have the same initial scores, but transfer members vary in initial efficiency.

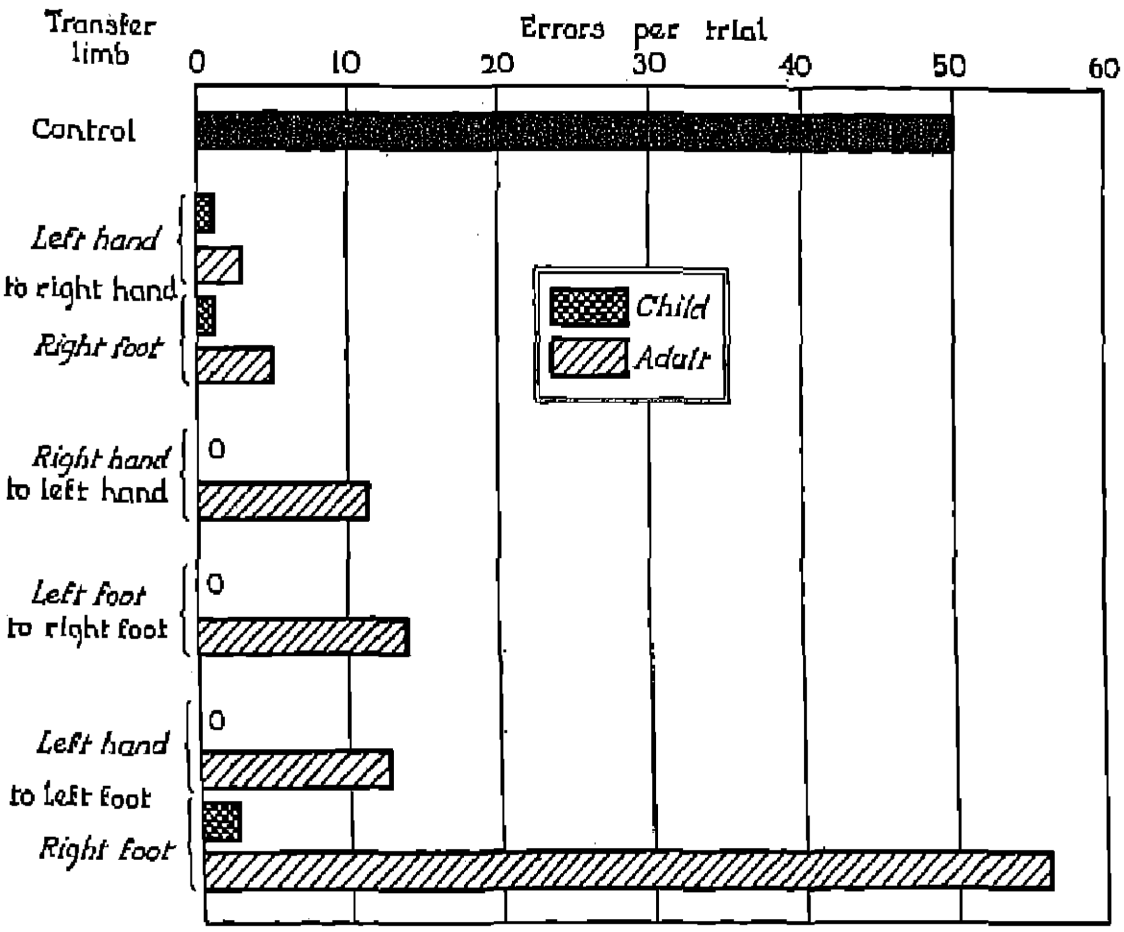

FIG. 6. FIRST TRANSFER ERROR SCORES FOR CHILDREN AND ADULTS, EQUATED TO A COMMON SCORE FOR THE TRANSFER LIMB. (TRANSFER LIMB HELD CONSTANT)

Goal position and transfer scores

In the two maze patterns used, the true pattern had the starting point located at the lower right-hand corner, and the goal post at the lower left-hand corner. The bi-lateral mirror image reversed the positions of the two posts. A comparison of performance on the two patterns shows more errors made on the true pattern by both adults and children. No constant difference is shown for speed on the two patterns.

Learning from the limbs "own" side was differentiated from learning that started from the "opposite" side. The right side of the body is shown to make more errors when it starts from its "own" side and the left side of the body when it starts from the "opposite" side. This merely reinforces the statement just made, namely, that more errors are made on the "true" pattern by both age groups. In every instance, greater accuracy is shown for the clockwise as opposed to the counter-clockwise movement.

For speed, both age groups obtain higher scores for initial and final trials when tracing begins from the limbs "own" side.

On the basis of these findings the following conclusions seem justifiable:

1. Speed is always greater for hands than for feet, and always indicates a condition of "cross-gaitedness" by showing the superior hand to be diagonally opposite the superior foot. An inverse relationship between the development of speed and accuracy holds for the right hand. The hand of greater initial speed makes the smallest relative gain in speed. The right foot has the greatest capacity for gain in speed, and the right hand the greatest capacity for gain in accuracy. Hands have greater capacity for gaining accuracy than do feet.

2. Greater accuracy is shown for the right side of the body for children and the left side for adults. Relative gain of speed is greater for the left side of the body for children, and the right side for adults.

3. Initial speed, ability to improve in accuracy, and the differences in speed and accuracy between the right hand and other limbs increase markedly with age and experience. Initial accuracy, the ability to improve in speed, and the number of trials taken for learning decrease with age and experience.

4. Practice decreases age differences in speed, and speed differences between the two hands. It also decreases speed differences between the right foot and the left foot for adults, but increases these differences in children.

5. Transfer speed and accuracy scores are affected by change in pattern, limbs, and sides of the body used. Accuracy and speed are to some degree at least dependent upon the position of the starting point of the maze in relation to the hand or foot used for learning. Greater speed is always obtained when the limb begins at its "own" side of the pattern.

The amount of transfer coming to an idle limb, and the amount coming from a given learning limb vary according to the direction taken. Better positive effects are always obtained when going from the less efficient to the more efficient limb. (Efficiency in this case is based on initial trials.)

6. Transfer scores show positive speed and accuracy effects for all idle limbs of adults. For children both positive and negative effects are obtained; the right foot in the learning position results in the best transfer scores for each of the idle limbs. Transfer scores improve with age.

7. Errors for this study appear to be a function of the direction of the culs-de-sac, and their positions relative to the goal. Culs-de-sac showing the greatest number of entrances lead most directly to the goal. Goal direction is learned before distance or total maze form. Form is learned before distance. Learning, progressing clockwise, shows greater accuracy than the counter-clockwise movement.

8. Up to a certain level of efficiency an increase of speed appears to be accompanied by an increase in accuracy. Beyond this level increase of speed appears to be developed at the expense of accuracy. This indicates that greater skill in movement, with its accompany-

ing confidence, produces greater inaccuracy. This does not appear to condition the capacity for improvement through practice. This suggestion follows: that early emphasis upon accuracy for the purpose of developing necessary caution may be the best practice in motor learning.

9. The size of the transfer score seems to be determined in a large measure by the efficiency of the transfer limb, and to a lesser degree by the amount of effort exerted by the learning limb. It would appear from this that where transfer in motor learning is desired, training of the least efficient limb is most economical.

10. Adults appear to make a transfer-tracing with little or no attention to sensory cues. A lack of positive transfer may then be largely a matter of close attention, and therefore a reverting to the earlier learning stages of the specific problem. The lack of positive transfer would be then, to some degree at least, a matter of adjustment. Greater experience and general practice as demonstrated by the adult group in this study tends to produce greater ability for improvement and better transfer scores. These differences are markedly greater when the adult right hand—the hand of most highly differentiated practice—is compared with the other limbs. For children, hands learn more quickly than do feet, and the right hand shows ability for greatest improvement.

11. These facts appear to indicate clearly that training operating in the learning of this problem was of a general rather than a specific nature.

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Brief Reports

Comprehension of Some Sizes, Shapes, and Positions by Young Children[1]

STUDIES of language comprehension have been meager and for the most part confined to short items in intelligence tests, measuring the comprehension among children of objects or activities which are constantly in their environment. Practically the entire story may be found among items in the Kuhlmann and Stanford revisions of the Binet test, those included in Gesell's and Descoeudres' norms, and more adequately in the recently published tests of Van Alstyne. On the other hand, studies of the *use* of language have been considerably in number. The present investigation is an attempt to bridge the gap ever so little between our knowledge of language usage and of language comprehension among preschool children. It was undertaken specifically to discover what sizes, shapes, and positions commonly known to adults are comprehended by young children and to devise methods for determining this. To this purpose two simple experiments were contrived.

PART I

The first experiment consisted of two four-page booklets, one of which was the duplicate of the other. On each page were pasted 6 bright blue figures such as squares, diamonds, half-moons, stars, triangles, crosses, circles. Five of these items appeared in both the vertical and horizontal positions. The experimenter kept one booklet and gave the other to the child with the instructions:

"I am going to play a game with you. Here are two books—one for you and one for me. They are just alike. See? (E opens both books and shows S the similarity) I am going to try to fool you, but don't you let me. You point to the one that I NAME, and not to the one that I point to. Do you understand? I am going to point to the wrong one, just to try to catch you. Now you be sure to point to the one that I NAME. Ready! Point to the diamond."

This game is similar to one played in the University kindergarten in which the teacher gives a command and expects the children to do as she says and not as she does.

The experiment was given to 33 kindergarten children at the Institute of Child Welfare, University of Minnesota; it was repeated on 20 of these children for the purpose of computing reliability. One point was given for each correct response. Scores on the initial test range from five to nineteen out of a possible 24 with a median score of 11. There was no correlation

[1] From The Institute of Child Welfare, The University of Minnesota.

between initial scores and IQ's in this restricted age group.

Consistency as measured by the percentage of identically correct responses on the retest ranged from 78 per cent to 100 per cent with a median of 90.5 per cent. The consistency when wrong items were included ranged from 33 per cent to 79 per cent with a median of 60 per cent, a result suggesting that although there was a high degree of reliability on the items that were really known, there was little consistency in confusion or error on the unknown items.

The percentage of correct responses for each item are given in table 1, together with a percentage of consistently correct responses given by the 20 retest subjects. The items that are known to an extent of 90 per cent or better by these kindergarten children are the moon (crescent), the half-moon, the star, the cross, the circle, square, and diamond, and all of these items were consistently correct for more than 90 per cent of the retest group. The small percentage of recognition and the lack of consistency on the pyramid, the wavy and jagged lines, the vertical oblong, triangles, and the cylinder and hexagon indi-

TABLE 1

Part I. Per cent correct responses and item-consistency

ITEMS	ORIGINAL TEST (33 SUBJECTS) PER CENT CORRECT RESPONSES	RETEST (20 SUBJECTS) PER CENT CONSISTENTLY CORRECT
Moon (vert. crescent)	100	100
Star	100	100
Half-moon (vert.)	91	100
Moon (horiz. crescent)	88	100
Cross	82	100
Half-moon (horiz.)	73	100
Circle	67	100
Diamond (vert.)	64	100
Square	64	93
Diamond (horiz.)	61	93
Slanting line	42	94
Oval (vert.)	42	70
Pyramid	36	50
Wavy line	36	40
Triangle (scalene)	36	75
Oblong (vert.)	28	57
Jagged line	24	40
Oblong (horiz.)	22	60
Oval (horiz.)	22	60
Triangle (rt. angle)	18	100
Cone	15	100
Triangle (Isosceles)	15	60
Cylinder	13	0
Hexagon	12	0

cate that these items were not known by the group. On the other hand, all of the items except the cylinder and hexagon were known, and consistently so, by two or more children, indicating that the ability to recognize these shapes is present in some five-year-old children.

In every case the vertically placed items were known by a larger per cent of the subjects than the horizontally placed ones.

The reliability of this method for measuring comprehension is high enough to warrant further experimentation with it or with some similar method, such as that of Van Alstyne. The application of the method with children under the kindergarten level has not been determined because the items included in this test were too difficult for use below that age.

PART II

The second experiment on comprehension was one where in a sand table was arranged with a forest scene including hills, lakes, a fence, a bridge, a teddy bear and other items of interest to the child. A story about the adventures of the teddy bear was told to each child, and he was asked to make the teddy bear do what the story indicated. The following is a sample of the story, which contained twenty-five words of position, size, and shape:

"Once upon a time Jack Bear stood beside the tree where he lived, and thought, 'I'm tired of staying here all the time. I wonder if I can find a nice place to go where I can have some fun!' While he was thinking hard about it, he jumped *forwards* and he jumped *backwards*. (Will you make him jump forwards? And make him jump backwards?). . . . He started out on his journey and soon decided that he needed a walking *stick*. . . . *There were so many sticks there* that at first he didn't know which one to take. . . . He looked them all over, and then picked up the *crooked* one. (Will you pick out the crooked one for him?) 'I don't want that,' he said, and laid it *behind* him. . . . " etc.

After each critical work or phrase the experimenter paused and asked the child to make the teddy bear perform the act. If the child did not comply immediately the experimenter repeated the request twice and then went on with the story. The reliability of the method was checked by a second story about the adventures of a boy and girl doll, one of which the child manipulated in the appropriate ways. The same toys and objects were used, but the scene was given variety by a rearrangement of them; the same critical words were introduced into the story in a different order.

The teddy bear story was told to 40 kindergarten and nursery school children at the University of Minnesota, and the second, in order to estimate reliability, to 14 of these children. The initial scores ranged from five to twenty-five out of a possible 25, with a median of 18. The median percentage of consistency by items was 86 per cent; the median consistency for the 14 subjects, 83 per cent. This indicates that one administration of a test of this sort gives fairly reliable information as to the child's knowledge of these words.

In table 2 the percentage of correct responses on the initial test is given by age levels, and also the percentage consistently correct for the retest subjects. The italicized figures represent the items passed by 60 per cent or more

of the subjects. It is significant that every item known by the three-year-olds is also known by the four- and five-year-olds, and similarly, that every were, "rough," "narrow," "broad," "far," "near." "Shallow" and "smooth," however, do not show a high consistency.

TABLE 2

Part II. Items recognized, by C.A. distribution: 60 per cent or above correct indicated by italics

ITEMS	PER CENT CORRECT, INITIAL TRIAL			PER CENT CONSISTENTLY CORRECT (14 SUBJECTS)
	30 to 41 months, 6 subjects	42 to 53 months, 10 subjects	54 to 65 months, 24 subjects	
over	*100*	*100*	*96*	92
big	*100*	*100*	*100*	100
crooked	*83*	*60*	*100*	86
under	*83*	*80*	*100*	92
high	*83*	*90*	*100*	100
long	*67*	*80*	*100*	92
tall	*67*	*90*	*100*	100
thin	*67*	*90*	*88*	92
1				
on top	50	*90*	*96*	100
behind	33	*80*	*100*	92
bumpy	33	*80*	*96*	92
deep	17	*80*	*92*	71
pointed	33	*70*	*100*	86
shallow	50	*60*	*75*	57
2				
few	17	20	*92*	70
forwards	33	30	*88*	70
backwards	33	30	*88*	71
tiny	17	50	*88*	80
smooth	17	40	*75*	57
hugh	0	30	*63*	79
3				
rough	17	30	50	86
narrow	17	20	55	86
broad	0	40	25	79
far	0	20	50	71
near	0	20	41	71

All items above 1 were passed by 3-year-olds; all items above 2 were passed by 4-year-olds; all items above 3 were passed by 5-year-olds; all items below 3 were not passed by any group.

item known by the four-year-olds is also known by the five-year-olds. Furthermore, in general the items are recognized in an increasing percentage of the cases at the higher age levels. The items not passed by any age group

From the standpoint of motivation this experiment is excellent; in fact, the experimenter was not able to enter the playrooms without being assailed by some child who wanted to play with her.

In the second method the number of alternatives for each "test" item was not constant; there were, for example, four sticks to test "long," "crooked," "pointed," and only two boards, a narrow and a wide one, to test "narrow." The technique should be further developed, then, to include at least four alternatives at each choice-situation. It seems advisable to the experimenter, too, that a series of entirely different test-situations should be set up to validate the measures obtained with this method. Significant possibilities would seem to be offered by th e use of this method for other investigations of meaning in young children.

Both parts of this experiment give a reliable instrument for determining language comprehension, the first useful for kindergarten children, and the second for both nursery school and kindergarten children, above the age of two and one-half years.

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A Study of Thumbsucking in Infants from Two to Seventeen Weeks of Age[1]

THUMBSUCKING is a subject on which there is much discussion, but little investigation. The literature on the subject is scarce, based in the main only on general observation, and sometimes contradictory.

The best study is that of Lewis and Lehman (8, 9) which is based on the observation of 170 children and covers a period of five years. It was possible to observe the children over the entire nursery school period of three years, and to make casts of their dentition. It was found that 30 of the children sucked their thumbs. All but 2 contracted the habit in the first year of life, and 9 sucked practically from birth. The time of breaking the habit ranged from nine months to six years. There was a definite preference for the right thumb. All of these children sucked their thumbs at bedtime, and less frequently when engaged in various activities. A comparison of the casts of the dentition made over a period of years shows that in 24 cases there was a definite malocclusion of the deciduous teeth. If the habit were corrected before the age of 6 years, the malocclusion tended to correct itself; if not, the malocclusion tended to remain static. The malocclusion always showed a forward displacement of the premaxillary bone and of the upper incisors, with an occasional reclusion of the lower in-

[1] From the Institute of Child Welfare, University of Minnesota.

cisors. The displacement was always toward the side of the thumb sucked, and if both thumbs were sucked, the displacement was symmetrical.

The literature on thumbsucking may be summarized briefly under three heads. As to the frequency, onset, and persistency of the habit, thumbsucking may be considered a normal behavior type for very young infants. It is often present from birth, is generally contracted in the first year of life, and may have its beginnings in the random movements of the child. It decreases with age, being most common under 6 years. It is classified as a sensory-satisfying habit, and is more common with nervous children, as they contract the habit earlier and are harder to break.

The detrimental results which are said to result from thumbsucking are drooling, malocclusion of the deciduous teeth, and possible malocclusion of the permanent teeth if the habit is not broken before 6 years of age.

To break the habit in very young children, gently remove the hand from the mouth and give the child something to hold. With older children, an appeal to pride is most effective. The use of a cuff or wire "sleeve," taking the child away from his play to suck his thumb in front of a mirror for 10 minutes, psychoanalysis, taking toys to hold when going to bed, holding the bedclothes, and positive suggestion are the best remedies.

The present study has for its purpose to discover how early in life thumbsucking appears as a definite habit. Subsidiary to this problem is the question as to whether or not there are typical hand, arm, and mouth activities in early infancy.

The subjects of the study were 25 babies, 10 boys and 15 girls, who were observed at a maternity home for unmarried mothers.[3] The infants ranged in age from fifteen days to seventeen weeks. The total number of observations recorded is 354. There is an average of twenty-five to 40 observations at each age level from three to fourteen weeks.

OBSERVING THE INFANTS

After two preliminary visits, the experimenter listed the activities she wished to observe, and devised a code and record sheet. This code, which was memorized, is listed below with the definitions.

Position of arms: U. C. under cover; D. down; Chest. the arms in such a position that the hands would be resting between the baby's waist and chin, and the arms close to the body or on it; Up. the arms held close to the body, and the hands lying between the chin and the top of the head; Ohd. the arms close to the body, the hands resting above the level of the top of the head; S. the arms stretched toward the sides of the crib.

Movement of arms: Rand. the seemingly aimless waving movements of the arms; Q. the arms quiet; Stretch. Stretching.

Hands: Ball. flat closed; Curl. the slightly flexed position of hand; Spread. the fingers spread out, and the hand quite definitely flat; Clasp. the hand clutching something; Rub. rubbing, the hand being either ball, curl, or spread, this being recorded separately; Rand. F. a seemingly aimless finger movement.

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[3] The writer thanks the matron and nurses of the St. Paul Salvation Army Maternity Hospital for Girls for their coöperation in the study.

Mouth and sucking activities: Smi. smiling; Op. Q. mouth open and quiet; Clo. Q. mouth closed and quiet; Cry. crying; Voc. vocalizing, cooing, grunting, sounds other than crying; Hic. hiccup; Y. yawning; Sn. sneezing; Cough. coughing; L. lip sucking, the lower lip being drawn in slightly and sucked; Tg. tongue sucking; Ch. chewing movement of mouth; C. cuff sucking; Mit. sucking mitten that has been placed over the hand as a training device; Cov. sucking covers of crib; T. sucking thumb; 1, 2, 3, 4, sucking fingers, numbered beginning with the index finger; F. sucking fist; B. blowing bubbles between lips.

The record sheet provided space to record whether the baby was awake or asleep, the activities of the right and left hands, and the mouth, in addition to date, time of the observation, and age in weeks. Timing was by stopwatch.

Each baby was observed twice in one day, on an average of 2 days a week. Each observation lasted 30 seconds, and there was an interval of about fifteen minutes between the 2 observations. All observations were made between three and four in the afternoon, the feeding periods being at two and five, and the babies were taken up only once in this interval, for changing.

The observations of the experimenter were checked by comparing them with those of a second observer who made three visits to the hospital, and observed simultaneously and independently. There was 76 per cent agreement between the records, 14 per cent disagreement, and an omission of 10 per cent on the part of the second observer.

ARM AND MOUTH HABITS

Thumbsucking and mouth activities

Of the 25 babies in this study, 11, or 44 per cent sucked their thumbs, fingers, or fists at least once during this series of observations. Finger-sucking was noted 50 times in the entire series, and at every level from three to seventeen weeks. Finger-sucking occurred in 14 per cent of the total number of observations. There is a definite preference for the right thumb (28 cases), with the left fist ranking second (6 cases). More sucking occurred while the baby was awake (36 cases).

The most common mouth activity while the babies were awake was crying, which occurred in 52 cases out of the 263 recorded mouth activities, or 19.8 per cent. The babies had their mouths closed and quiet 42 times, or 16 per cent. The third most frequent activity was tongue sucking, noted 26 times.

In 59 per cent of the cases recorded, the babies slept with their mouths closed. In 42 per cent of the cases the mouth was open. The most frequent of the other activities was lip sucking which occurred 8 times (4 per cent).

Hand and arm activities

The "ball" position of the hands was most frequent both waking and sleeping, occurring 55 per cent and 73 per cent respectively. Clasping ranks second among the waking activities, 14 per cent. This activity appeared first at the age of 5 weeks, when there was one case with the right hand. Clasping with the left hand did not appear until the age of 8 weeks, when there were 2 cases. Rubbing appeared at 7 weeks, one case with the left hand being recorded, and it was followed by a record on both hands the very next

week. This activity occurred only 10 times (3.5 per cent). Random finger movements rank third as a waking activity, scoring 28, or 10 per cent. Sleeping activities are few, the spread and curl positions tying for second place with 10 per cent. All the other activities occurred very seldom.

The most common position of the arms, both sleeping and waking is the "up" position (56 per cent and 37 per cent); the chest position was second in preference in the waking state (34 per cent) and the under cover position in the sleeping state (22 per cent). The latter position is less frequent when the baby is awake, and in either case the position decreases with age. The side position, on the contrary, increases gradually with age. It was first noted at 5 weeks, and occurred in 10 per cent of the waking observations, and 6 per cent of the sleeping observations. The down and the overhead positions were more infrequent, occurring 3 per cent or less in either state.

It is to be expected that the baby would hold its arms quiet while sleeping, and this was found in 85 per cent of the cases recorded. It is interesting to note that stretching occurred 42 times (12 per cent) while the babies were asleep, and in only 1 case was there a stretching of one arm without a simultaneous stretching of the other arm. This activity occurred only 7 times (2 per cent) in the waking cases. The quiet position of the arms is most frequent even when the babies were awake, occurring 56 per cent of the time, with random movements second with 43 per cent.

Sleeping and waking

The number of waking observations increased with age, as was to be expected. This is especially noticeable at about seven weeks. Before the age of seven weeks, only 42.2 per cent of the observations are on babies who are awake, while above seven weeks, 61.9 per cent of the observations were made while the babies were awake. The total waking observations were 54.8 per cent.

CONCLUSIONS

1. Eleven of the babies of this study sucked their thumbs. All but one of them sucked at more than one weekly age level; thus the sucking can be considered habitual for the early period of infancy covered in this study.
2. There was a marked preference for the right thumb.
3. The most common positions of the arms for very young infants is the chest or up position described in the study.
4. Clasping, rubbing, arms stretched out to the side or overhead appeared in this study in the second month of age and appeared with increasing frequency as age advanced.

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The Intelligence of Isolated Mountain Children[1]

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THIS report of the results of intelligence tests made of mountain children is part of a larger study begun in the summer of 1929 to determine the cultural influences which affect intellectual, emotional and personality development and the influences determining the attitudes of mountain people living in relative degrees of isolation.

The communities studied were 4 hollows located approximately 100 miles west of Washington, D. C., in the Blue Ridge Mountains and a small village at the base of the Blue Ridge about the same distance from Washington to the southwest. Of great significance is the ancestry of these people. The Hollows were settled in the pre-colonial period by English and Scotch-Irish immigrants. When German immigrants were given most of the land in the Shenandoah valley surrounding these mountain ranges the English and Scotch-Irish people were forced up the mountainside. The topography of this region is such that the settlers were forced further within the mountains, settling in hollows surrounded by mountain ranges. There they built their log and mud cabins many of which still remain and are inhabited. Each of the hollows selected for study, Colvin, Needles, Oakton and Rigby are close to each other but are separated by comparatively high mountain ranges. Of these Hollows, Colvin is at the lowest level in social development. This hollow is small, consisting of a small number of families living in scattered, mud-plastered log huts. There is no road, except for a trail, to the outside world. One small log and mud cabin is rented by the county school board for a school. There is no general meeting place and the church meetings which have been held in the past have been discontinued except for a very occasional revival meeting. With three exceptions, the adults are illiterate. They are descendents of the original settlers who married relatives and mixed very little with the people outside of the hollows. Colvin Hollow is so named because most of the inhabitants are Colvins. Many of the younger children do not know their last names. They identify themselves, for example, as Sadie's Bennie or Dicy's Willie.

Needles Hollow, adjacent to Colvin Hollow, is next in the scale of social development. It is reached by a

[1] From the University of Chicago. Studies of mountain people in progress under a grant from the Payne Fund of New York. Dr. Key of the Washington Child Research Center gave and tabulated most of the tests.

rocky road from a small hamlet at the base of the mountains. Its patches of ground, from two to five acres on the average, surrounding the cabins, approach the status of small farms. It is a more socialized community and many of the adults are literate. The children have had good school advantages compared to Colvin Hollow.

Oakton Hollow, next higher in the social scale, is separated from Colvin Hollow by a high mountain. The road to the valley is passable for old Fords and wagons most of the year. The Hollow boasts of a combined general store and post-office and many of the inhabitants receive mail and an occasional magazine. There exists a greater social consciousness than in Colvin or Needles Hollows. Oakton Hollow has had about four months of school each year for some time. The people are fairly prosperous although they have but little surplus farm products to sell in the valley.

Rigby Hollow, culturally further developed, can be reached from the valley much more easily than any of the other three hollows. The present school was established by missionaries about nine years ago and has been conducting regular school terms. Church and Sunday School services are held regularly. The farms are larger than those of the other hollows and there nearly always is a surplus which is sold in the valley. School terms have been about seven months each year for the past eight years and approximately 75 per cent of the inhabitants are literate.

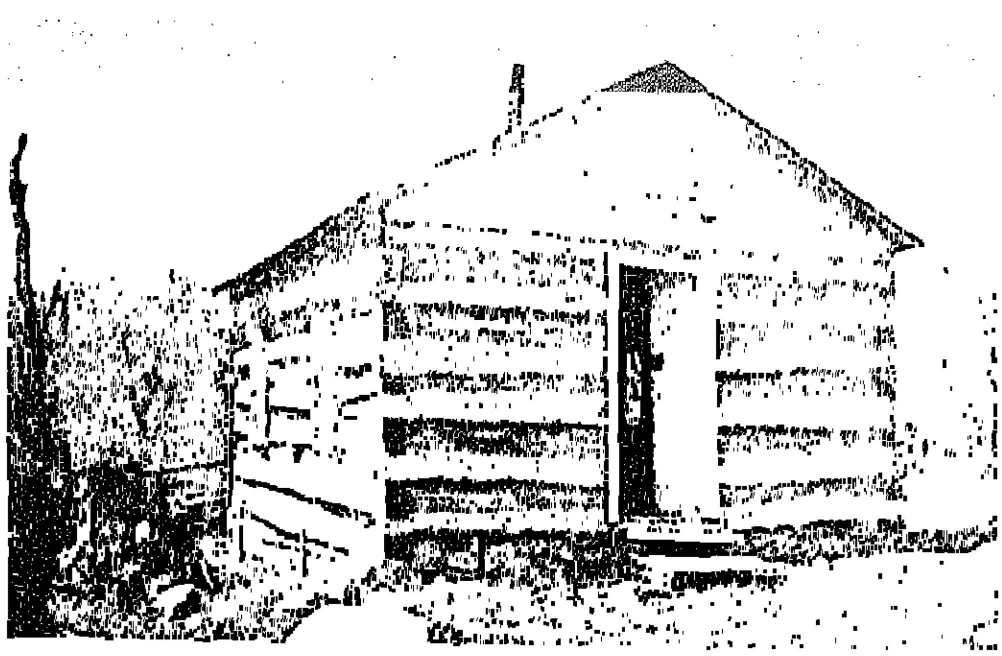

FIG. 1. THE COLVIN SCHOOL HOUSE

For purposes of comparison a small farm and sawmill town, Briarsville, was chosen. It is located at the base of the mountains to the south of the Hollows. The town has a hard surfaced road connecting it with the principal cities of Virginia. The school building is a modern structure with 4 classrooms, 3 of which are used regularly. The school board employs 3 well-trained teachers. The town has a

good general store, telephones, and receives newspapers.

The comparison of the intelligence test results of the mountain children with those of the children of Briarsville is especially significant in view of the origin of many of the residents of this town. Many of the inhabitants migrated from the mountains in the past to obtain work on the adjacent farms and in the sawmill. At first socially isolated from the "first" families of this town, the children now mingle freely. It was thought that a comparison of intelligence tests results of the mountain children with those of Briarsville would be much more significant than with children of an average town or city.

Intelligence tests were given to more than half of the children of the 4 mountain hollows and Briarsville. Not every child was tested, for some of the younger children could not be taken to the place where the tests were given, and a few of the others refused to cooperate. Nine tests were used: the Stanford-Binet; The National Intelligence Test, Scale B, Form 2; Pintner-Cunningham Primary Mental Test. For performance tests the following were employed: Manikin, Seguin Form Board, Mare and Foal Healy Puzzle "A," the Knox Cube Test from the Pintner-Patterson scale of performance tests, and Goodenough's Drawing of a Man.

A representative sample of the school population thus was tested. A total of 386 tests were given to the children in the mountain communities and 198 in Briarsville. The children in Briarsville were not given Stanford-Binet tests because of the difficulty in organizing the program there. One hundred two children were examined in the mountain communities and 81 in Briarsville. In addition to an investigation of test scores and mental age results, a qualitative analysis of the responses was made.

FIG. 2. A COLVIN HOLLOW FAMILY IN THEIR FRONT YARD

Table 1 shows the length of the

school term in 5 communities since 1918. The Colvin Hollow school has been the most irregular with the least number of months of schooling. Between 1918 and 1929 Colvin Hollow has had only 16 months of school at irregular intervals. It was impossible to find an exact record of the years in which school was held. Rigby Hollow has the most regular school term of the mountain communities.

The superiority of the Briarsville school system is shown not only in the greater number of months in which school was held in the past eleven years but also in the regularity of the school term.

TABLE 1

Length of school terms in months in the five communities

YEAR	COLVIN	NEEDLES	RIGBY	OAKTON	BRIARSVILLE
1918–19	16 months	?	4	6	9
1919–20		2	4	6	9
1920–21		2	4	6	9
1921–22		0	4	6	9
1922–23		4	4	7	9
1923–24		2	4	5.5	9
1924–25		2	7	6	9
1925–26		2	7	4	9
1926–27		2	7	5	9
1927–28		2	7	3	9
1928–29		5	7	5	9
1929–30		7	7	7	9
Total months 1918–1930.....	16	30?	66	66.5	108

The per cent of children retarded in school in the mountains and in Briarsville is given in table 2, taking 6 to 7 years as the age standard for first grade, 7 to 8 for second grade, and so on. Children at the grade or accelerated and those retarded more than six grades are not included. Only one child in the mountain communities was found to be in a grade higher than his chronological age warranted and thirteen were "at grade."

TABLE 2

Per cent of children showing age-grade retardation

AGE-GRADE RETARDATION	BRIARSVILLE	MOUNTAINS
1	22	20
2	38	17
3	16	12
4	12	16
5	4	8
6	1	8

It is difficult to estimate age-grade retardation accurately in the mountain communities because of the loose standard of requirements for grades. Grade placement depends entirely upon the judgment of the teacher, although her estimate sometimes is obtained by a formal examination. The fact that only a few children were accelerated is not a real indication of a general lack of ability but probably means that the

teachers do not use the same system of promotion as in a city school. Psychological tests of intelligence and achievement have never been given in these communities and there is, therefore, no way of measuring the real abilities of the children. In many cases the older children are left to their own resources in the school room as the teacher spends most of her time with the younger children.

Table 3 shows the average intelligence quotient of the children in the four mountain communities and Briarsville. The standard deviations fall within the range of reliability. The curves of distribution of scores in general were similar to those of children in an average community. The average intelligence quotient of the Briarsville children was higher than that of the mountain children in every test, and had a smaller standard deviation. The results give further evidence of the effect of systematic training upon intelligence test ratings, a factor often slighted in comparative studies of intelligence test scores.

The dependence of the intelligence quotients on the kind of test used is shown in a comparison of the average I.Q.'s of the mountain children on the different tests used. The highest average intelligence quotients are found in the tests presumably most independent of language and of school training, and lowest in those utilizing language ability.

When we examine the results of the tests in Briarsville, on the other hand, we find that while the highest average I.Q. was obtained in the performance tests, the next highest was on the National intelligence test—a test dependent upon language ability. This may be additional evidence that systematic and consistent training in a community of a comparatively high order or social organization is a stimulus to the development of the kind of intelligence we ordinarily measure by tests.

TABLE 3

Average intelligence quotients according to various tests

TESTS	MOUNTAIN COMMUNITIES			BRIARSVILLE		
	Number of cases	Average	S.D.	Number of cases	Average	S.D.
Stanford-Binet	32	61.5	11.2			
National	24	61.2	17.5	50	96.1	15.2
Pintner-Cunningham	42	75.9	17.1	31	87.6	13.0
Four performance tests:						
Year scale	54	83.9	24.8	10	118.6	17.1
Med. M.A. scale	54	79.1	23.8	10	95.6	16.3
Drawing of a man	63	72.3	17.9	67	76.3	17

These mountain children are slow and cautious with a slow tempo of response. The way in which the environment influences a child's method of responding probably has not been studied sufficiently in intelligence test results. In scoring the results it was found that the children rated highest

in those tests in which the tempo of the directions and the responses was slowest. It is not surprising to find that the children rated highest on tests which took into account least the factor of speed. The children in these mountains live in an environment which does not put a premium on speed involving abstract comprehension. This sort of failure differed in degree in the various communities. The Colvin Hollow children failed most frequently in tests involving calculation, in part because the terms used were foreign to them. The difficulty of evaluating failures on simple problems is due in

FIG. 3. THREE COLVIN HOLLOW SCHOOL CHILDREN

The majority of these children show strabismus, and one of the children shown in this picture is forced to hold his head high and to the side in order to see because of his squint.

and the problem of evaluation of their test scores thus is complicated further.

The Stanford-Binet test at once might be considered inadequate because of its evident dependence upon language and school training. Analysis of the successes and failures on this test further showed its unadaptability for studying this type of children. Failures were most evident on items part to the uncertainty of knowing whether the children failed because of insufficient language comprehension to understand the directions. Rote memory was found to be above the average of other test results, but the most common failure in Colvin Hollow was in the reversal of numbers. Following the giving and scoring of the tests a number of children were given

practice in the reversal of the number sequence 1–2–3. After it was thought that they could reverse this sequence other numbers containing four figures were given. As an example, the sequence of 6–5–2–8 was reversed by most of the children as 6–5–4–3–2–1.

The almost universal failure of the mountain children in the ball and field test indicates their lack of ability to comprehend and solve a simple problem involving foresight and planning ability. Few of the children appeared to have a plan for finding the ball in a circular field. Usually a line was drawn in the center of the diagram and in some cases this was varied by dots indicating trees. Many children of Colvin and Needles Hollows could not understand the directions of the ball and field test. They had little comprehension of the meaning of "field" and were astonished at a ball being lost. (Most of the children never had seen a ball.) One boy of 13 made a curious effort. He drew a number of small rough circles in the enclosure which he explained as representing trees. Then he drew a line from one circle to the next connecting them. He then stated that he was hunting for the lost article under the trees. In this and other cases it was very difficult to assume, as one is forced to do in scoring the test, that the failure indicates a deficiency of innate intelligence even on that one test. Although it is not assumed that a child must have experience in the performance called for on a given test, and indeed such direct experience would mitigate the significance of the score,

FIG. 4. A GROUP OF COLVIN HOLLOW SCHOOL CHILDREN IN THEIR BEST DRESS

it can be assumed that a child must have had some approximate or similar experience. These mountain children live in an environment calling for little planning and ingenuity expected of an average child of not more than nine years.

Evidently space and form differentiation as employed in these tests are relatively foreign to these children. Only one of the younger children in Colvin Hollow correctly copied the drawing of a diamond.

An impoverished environment probably acts as a depressing factor on the development of intelligence. The problem of the effect of the environment upon the development of intelligence has attracted the attention of many psychologists in recent years. Some (1) believe that the environment may act either as a stimulant or as a depressant to the intelligence of young children. Others believe that the capacity for the development of intelligence is influenced but little by the environment. It is the belief of many psychologists that some tests rate children higher at certain age levels than at others. For example, the Stanford-Binet in some cases gives the very young child a comparatively higher rating than an older child. In examinations of nursery school children over a period of about eighteen months of intensive training, it was found (3), that the intelligence quotients obtained by the Kuhlmann scale varied considerably. There was a tendency

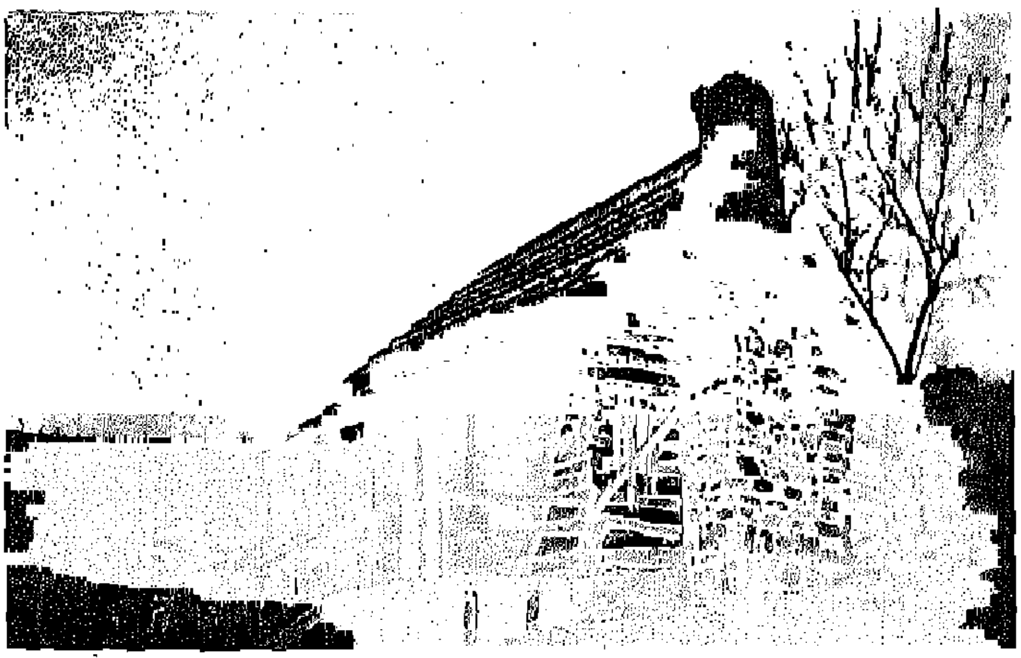

FIG. 5. HEADQUARTERS FOR THE FIELD WORKER

The items which the children in all the hollows passed most consistently were the mutilated pictures, counting backwards from 20, arranging weights and comprehension of pictures. In 2 of the hollows most of the children could not name the days of the week in correct sequence. This failure probably was due to the fact that they have no use for differentiation of days, since one day is like the next in its significance except for the days of going to school and staying at home.

ard homogeneity of the intelligence tients with continued attendance ı nursery school. The range of intelligence quotients on the first was 87, on the second 27 and on third 22. The duller and brighter dren approached an average in- gence quotient with repeated tests ›ontinued attendance in the nursery ›ol. *It was thought that the en- ›nment of the nursery school stimu- d the duller children to develop in- ›ctually.* The brighter children, the other hand, were not required develop further. A similar factor bably influences the development the mountain children. Adjust- nt in the mountain hollows does not essitate a high intelligence level. ellectual development therefore be- nes increasingly less rapid with in- ase in chronological age.

Table 4 gives the average intelli- ıce quotients on various tests ac- ding to increasing chronological age. shows a decrease in intelligence quo- nts with increase in chronological › for every test except the National, applied to the mountain children. The decrease in the intelligence quotients in some of the tests is as great from the 6th to the 10th year as from the 10th to the 16th year. *In some cases the decline in intelligence for children over 10 is greater than for children between 6 and 10.* An intelligence test is an indirect measure. An estimate of intelligence is based on the information the child has been able to obtain. In the mountain environment increments of information become less large with increases in age, and the seven-year-old has relatively more chance to gather information and to learn by experience than the twelve-year-old in the same environment.

TABLE 4

*Average intelligence quotient on five tests according to increasing chronological age**

›NO- ICAL ›E	NUMBER OF CASES		PINTNER-CUNNINGHAM		NATIONAL INTELLIGENCE		DRAWING OF A MAN		PERFORMANCE SCALE			
									Year scale		Med. M.A. scale	
	Moun-tains	Briars-ville	Moun-tains	Briars-ville	Moun-tains	Briars-ville	Moun-tains	Briars-ville	Moun-tains	Briars-ville	Moun-tains	Briars-ville
›–8	12–13	8	84	04			80	93	91		60	
›–10	15–23	4–22	70	91		117	66	82	84	119	76	93
›–12	5–16	5–20	53	76	66	101	71	69	86	108	70	87
›–14	7–12	16			67	91	69	73	83		83	
›–16	8–15	14			52	87	49	70	75		73	

The figures indicating the number of cases does not mean that every test was given he numbers indicated. The minimum and maximum number of children given a › at the respective chronological ages is shown.

In a study of Kentucky mountain children Hirsch (2), concluded that the slow decline of the intelligence quotient in the age groups tested was due for the most part to environmental factors.

Table 5 shows the per cent of cases below the average intelligence of the four mountain communities studied. The table shows, with some slight vari-

TABLE 5

Per cent of cases below the average intelligence of the four mountain communities

TESTS	COLVIN	RIGBY	NEEDLES	OARTON	BRIARSVILLE
Stanford-Binet	84	25	64	50	
Pintner-Cunningham	60	22	06	50	19
National intelligence		61	36		0
Drawing of man	100	20	63	60	47
Performance tests:					
Year scale	70	47	59	25	10
Med. M.A.	80	46	47	62	0

TABLE 6

*The relation of intelligence quotients to size of family in Briarsville**

NUMBER OF SIBLINGS	NUMBER OF FAMILIES	NUMBER OF CHILDREN TESTED	AVERAGE INTELLIGENCE QUOTIENTS		
			Pintner-Cunningham	National intelligence	Drawing of man
11	1	4	74	87	72
10	6	10	76	91	60
9	2	5	85	98	80
8	1	4	106	90	78
7	3	11	90	93	81
6	4	9	91	103	78
5	5	10	89	93	74
4	7	8	100	97	81
3	6	7	97	112	80
2	3	4	87	86	73

* Not all the children were given every test indicated in the columns.

TABLE 7

*The relation of intelligence quotients to size of family in the mountains**

NUMBER OF SIBLINGS	NUMBER OF FAMILIES	NUMBER OF CHILDREN TESTED	AVERAGE INTELLIGENCE QUOTIENTS				
			Pintner-Cunningham	National	Drawing of man	Performance tests	
						Year scale	Med. M.A. scale
11	1	7	90	77	54	94	95
10	2	5	108	57	83	115	103
9	5	8	99		60	71	64
8	6	16	74	55	62	88	70
7	6	13	69	37	67	71	85
6	6	7	84		67	68	65
5	7	15	66	74	73	77	66
4	5	8	78	61	76	85	87
3	3	6	81	63	69	74	75
2	3	5	83		67	81	81
Total	44	90					

* The test scores of only children are not shown. Not all the children were given all the tests indicated in the columns.

ation, that the per cent of cases below average intelligence increases with the decrease in the cultural level of the community. In Colvin Hollow, socially lowest in the group, the per cent of cases below average intelligence is considerably greater than in any of the other communities. Briarsville, the highest community culturally, had the smallest percent of cases below average with one exception. When each community is ranked according to the per cent of cases below average intelligence and an average rank obtained for the various tests, Rigby Hollow is second, Oakton Hollow third and Needles Hollow fourth.

Table 6 shows the distribution of intelligence quotients on three tests in relation to the size of the family in Briarsville. There is no consistent relationship between the size of the family and the average intelligence quotient. If these tests rate the intelligence of children fairly, it may be inferred that the size of the family has no effect on the intelligence of the children, but there are many arguments against such an interpretation. The children tested were not all of the same age. Since we have found that the intelligence rating of the mountain children depends upon the age of the child, the relationship between the size of the family and intelligence is not clear.

Table 7 shows the relation of intelligence quotients on four tests to the size of mountain families. There is little difference between the mountain and Briarsville children in the relationship between the size of the family and the intelligence quotients of the siblings.

SUMMARY

The results of the intelligence tests of mountain children living in varying degrees of isolation appear to corroborate the belief of many psychologists that the expression of intelligence, as measured by standardized tests, depends in a large measure upon the opportunities to gather information and upon the requirements made upon the individual by his environment. Since the ancestry of the children of all the Hollows came from the same stock the claim cannot be made that some of these mountain people are "degenerate" and therefore their children are expected to be retarded intellectually, a claim too often advanced for the supposed inferiority of isolated mountain children. Furthermore, as has been shown in this paper, the young children of the various Hollows do not differ greatly in intelligence, whereas great differences are found between the older children of the different Hollows. The only plausible explanation of the increasing difference with increasing age is that children develop only as the environment demands development. The Corbin Hollow environment is as stimulating to the child of four or five as that of Oakton or Rigby, but Corbin Hollow requires relatively little more of its older children whereas Rigby Hollow requires an ability for social adjustment met only by a high order of intelligence.

Finally, not only are the children of the communities of lower order of social development without adequate social stimuli but they also have few conflicts to spur them to attainment. A careful study of the conflicts of the

children of the different communities has shown that there is a direct relationship between conflicts and the development of intelligence as shown by tests, whether or not the relationship is causal. As these mountain communities ascend the scale of social organization and complexity the number of conflicts of the inhabitants increases also. The intelligence of the children also is highest in the communities highest in the scale of social development and lowest in the communities of lowest social development.

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From Reflex to Muscular Control in the Assumption of an Erect Posture and Ambulation in the Human Infant

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THE assumption of an erect posture and ambulation stand out as milestones in the phylogenetic development of the human race and the ontogenetic development of the human individual. It is customary to define the transitional stage from the mammalian to the human specie as that period when the animal began to stand and walk erect. Comparably, the transition from infancy to early childhood in the growth cycle of the individual is conveniently determined by the age at which the child begins to stand erect and walk alone. The fundamental principles governing these changes and modifications in the infant's acquisition of walking are essentially the same as the principles governing all behavorial growth in infancy and probably throughout life.

The emergence of standing and walking ability on the part of the infant has ever been of extensive general interest but in recent years it has assumed considerable scientific significance since it is claimed that accelerated development in these and similar traits is symptomatic of superior endowment. Everyone familiar with standardized tests and scales for measuring infant development—such as Gesell, (3) Linfert and Hierholzer (5), Hetzer and Wolf (4), Figurin and Denisoff, (2) and Bayley (1)—knows that such items as "sitting with help," "standing with help," "standing alone," "stepping movements," and "walking alone" occupy a conspicuous portion of the scales purporting to measure infant development. However, after more than ten years of such standardized tests and established norms even the child specialists are unable to explain satisfactorily why one perfectly normal infant should walk alone at nine months and another not until he is eighteen or twenty months old. Nor are they able to evaluate adequately the significance of these individual differences. Will the one infant walk any better when he is ten years old than the other and does it follow that he will display mental superiority?

Much of the difficulty arises from the fact that attention has been centered on determining *when* particular characteristics appear without proper analysis as to the process or the means whereby they are acquired. For example, "standing with help," "stepping movements," or "walking

with help" are items which appear in the scales anywhere from eight to twelve months. Yet it is an established fact that many newborn infants when supported at the axillae or when held merely by the hands will sometimes rest their body weight on their feet and will take prancing or walking steps. To be sure, the way the ten day old infant stands or walks with help is qualitatively very different from the way the ten month old infant performs this function. However, infant scales of development cannot attain maximum usefulness until these distinctions have been brought into relief. It would seem that the infant's inability to walk at birth is due more to an undeveloped equilibratory apparatus than to the absence of a walking mechanism. A primitive or vestigial mechanism is there, but it appears to be segmental and not integrated with related functions essential to upright ambulation.

In order to walk upright an individual must be able to support his weight, maintain his balance, and propel himself forward. The flexion and extension of the lower extremities at the two major flexion foci functions at birth and the big task ahead of the infant is to develop a resistance to and a control over the force of gravity. Most "partunates"[1] display a decidedly helpless response to the force of gravity. When raised from a supine to a sitting position his reaction usually is distinctively flaccid and he falls helplessly forward into a closed-jack-knife position. From all observable indication he is quite comfortable in that position. A few days later, however, he will show a slight resistance to this forward fall, will free his lower extremities from flexion beneath his body, thereby getting himself into a prone position, and occasionally the head may bob off the surface on which he is lying. With progressive development, increments in this resistance to gravity is quite evident (first in the region of the head and neck and then the trunk) until finally the baby is able to support himself a little while in an open-jack-knife position. Still later he can support himself in an upright sitting position though he is unable to get into that position without help. Finally he can not only resist gravity sufficiently to maintain a sitting posture, but he can carry the superior portion of his body counter to the force of gravity in order to attain a sitting position. The ability to ues his lower extremities against the force of gravity develops a little later. It is observed that the infant's increasing ability to counteract gravitational forces is exceedingly gradual in development and it has a cephalocaudal trend.

The reaction of the partunate when held in an upright position, supported at the axillae, is usually in keeping with his general picture of flaccidity. Ordinarily the lower extremities flex and abduct beneath the body. A few partunates and most neonates will occasionally extend their lower ex-

[1] A term indicating infants who are just born. Although it is not limited to a definite number of minutes it covers about the first fifteen or thirty minutes of life since it includes the time during and immediately following parturition. When the umbilical cord is dressed and the baby is taken to the maternity nursery, then he becomes a "neonate."

tremities and momentarily help support their body weight, as previously mentioned, or they will make pranc-

FIG. 1. Flaccidity of "Partunate" manifest in the dropping of the head toward the spine and an extension of the spine when the infant is raised from a supine to a sitting position.

FIG. 2. Older infant displays a tendency to flex the head and neck toward the chest, to flex the trunk slightly; the lower extremities are raised off the surface and the infant helps in rising from a supine to a sitting posture.

ing or walking steps. The posture of the infants when making these steps seems to have developmental significance: The spine is held vertical to the substratum. There is an exaggerated flexion at the two major flexion foci of the lower extremities, namely, the hips and the knees. Lo-

FIG. 3. Infant has sufficient power to raise her head (but not the trunk) off the surface in an effort to get from a supine to a sitting position.

FIG. 4. An older infant has sufficient power to push his trunk as well as the head and neck against the force of gravity in order to get from a supine to a sitting posture.

comotion is of the digital grade and usually of the scissors type, not unlike that of the spastic paraplegia suffering a lesion in the spinal portion of the pyramidal tracts. The upper extremi-

ties are ordinarily flexed and adducted, apparently unassociated with the propulsive movements of the lower ex-

FIG. 5. Flaccidity of "Partunate" demonstrated by this "jack-knife" position assumed when the infant falls forward from the sitting position and shows no resistance to the force of gravity in making this fall.

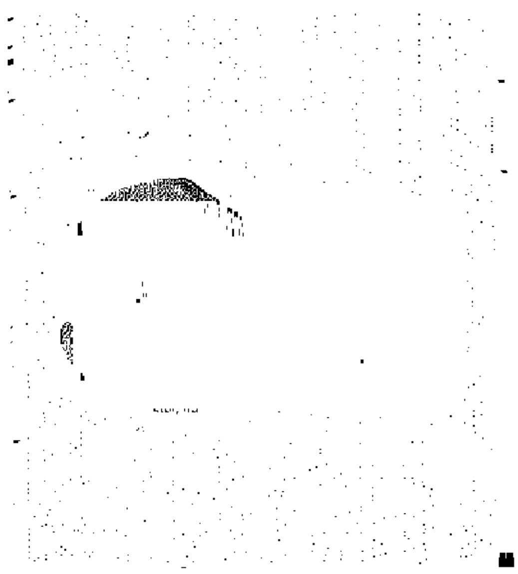

FIG. 6. An infant a few days old will free his lower extremities when pinioned beneath his body.

tremities. At a later stage it is observed that the flexion at the knee has greatly decreased although there is a marked flexion at the pelvis, rendering the posture similar to that of the anthropoid gibbon. Locomotion is still of digital grade though less of the scissors type. The crossing of the extremities is pedal, rather than on the legs, and stepping movements are less distinctly prancing in type. By and by the stepping movements tend to disappear and the infant, though retaining more or less the anthropoid posture, engages in a sort of rhythmical jumping. When stepping movements, a few weeks later,

FIG. 7. With further development an infant will support himself in a slightly "open-jack-knife" position.

reappear they show some tendency toward plantigrade, and, although the lower extremities are still held anterior to the trunk, functional use of the ankle joint as one of the flexion foci is emergent. Further growth tends to bring the trunk and lower extremities into a plane perpendicular to the surface and locomotion becomes more positively plantigrade. Early standing and walking alone are associated with a marked unsteadiness or dyssynergia and final development of the function of an erect posture and ambu-

lation is noted by a lessening of this dyssynergia and an increasing control and certainty on the part of the infant.

In so far as the development of an *erect posture and locomotion in infants* adheres to the general laws of functional growth the following interpretations and conclusions seem warranted:

(1) Certain types of activities appear to function on a reflex level before they become a part of a controlled muscular pattern. The reflexes tend

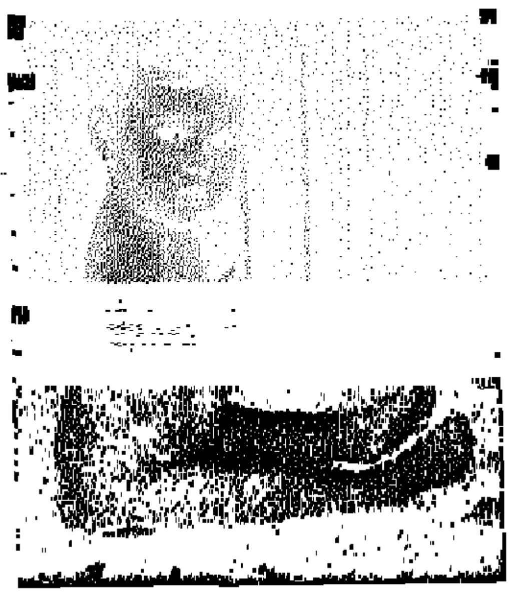

FIG. 8. Development is gradual and continuous until infant can sit perfectly erect though she cannot get into the sitting position.

to disappear before or about the time the controlled neuro-muscular pattern emerges. For example, there is a diminution of the early reflex stepping movements before the controlled process of walking becomes a part of the infant's behavior repertoire.

(2) There is no evidence of a sudden emergence of a new totally integrated pattern. That is to say, the infant does not use one distinct pattern of response and cast it off for the use of another pattern when a new phase in his development has become evident. Rather the new pattern unfolds, bit

FIG. 9. Flaccidity of "Partunate" shown by the flexion and abduction of the lower extremities, upper extremities flexed and adducted and the neck is flexed so that the chin rests on the chest.

FIG. 10. Infants a few hours old will when supported at axillae frequently make prancing steps. They are usually of the scissors type. Note the hyperflexion at the knees and hips, the adduction of upper extremities, and the trunk which is almost vertical to the substratum.

by bit, and dovetails with the old pattern and gradually the new pattern becomes more and more dominant

until finally it is superimposed upon the old pattern though in times of

Fig. 11. Note less flexion at knee joint—anthropoid posture; digital progression; and slight abduction of upper extremities, and progressive steps are disappearing.

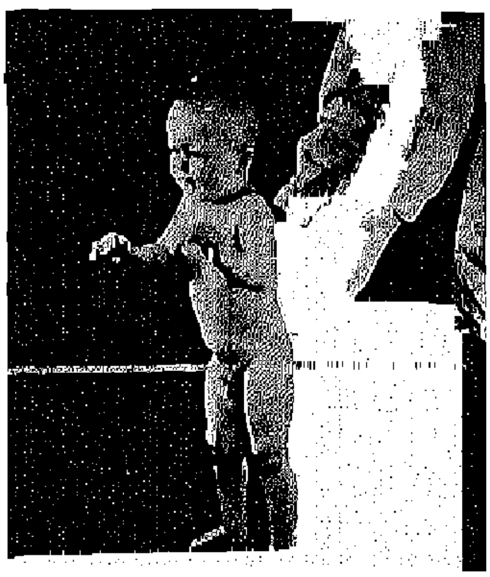

Fig. 12. Infant beginning to stand without support. Note that lower extremities and trunk are now in the same plane; upper extremities are abducted in helping to maintain balance.

stress and strain the infant will revert to the less mature response.

(3) Growth in the assumption of an erect posture and walking is extraordinarily gradual. Although the acquisition of the power of walking erect is obviously dependent upon a

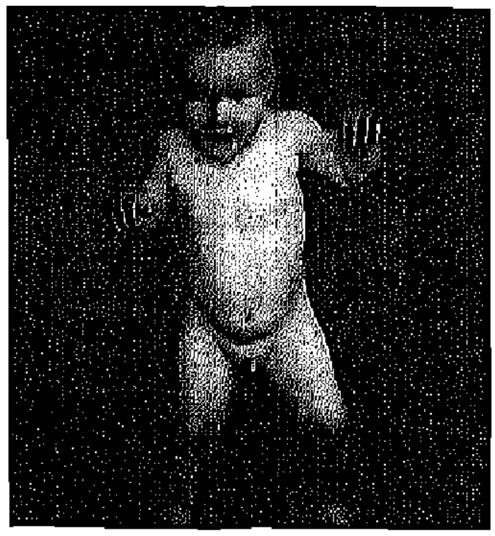

Fig. 13. Emergence of plantigrade walking steps. Progressive steps in upright posture but maintenance of balance is still quite unsteady.

Fig. 14. Infant now has considerable control over the process of walking. Note the use of the upper extremities and the evidence of associated movements in the right upper and left lower extremities.

degree of maturation or ripening of the nervous system it nevertheless has the essential elements involved in a learning process. In acquiring any

new reaction pattern the infant experiences a degree of uncertainty or dyssynergia. A decrease in this dyssynergic aspect associated with a particular reaction pattern and an increase in the precision and of the performance is unquestionably a type of learning. Such learning is not, however, of the trial and error, or analysis and selection, variety. For the infant, behavior development is not so much a question of eliminating false responses and selecting satisfying ones as it is an increase in the degree and precision of response, the initial pattern of which is the desirable. Infants tend to make a partial response rather than a false one and "learning" consists of a completion of the reaction pattern rather than selection and elimination of responses.

(4) Standardized tests and scales for measuring infant development can be of little practical value until these phases in the development of a single trait have been minutely analyzed and determined.

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The Development of Language in Twins

II. The Development of Twins: Their Resemblances and Differences[1]

Ella J. Day

INTRODUCTION

MAN'S curiosity in the unusual has led him into many fields of adventure. Twins, constituting about one per cent of the births according to Davenport (3) are both so rare and so different that science has for a long time been very curious about their origin, their resemblances and their differences. The dispute as to the relative importance and effects of heredity and environment in moulding human nature dates back to the ancient Greek philosophers and scientific workers always have felt that twins presented a special opportunity for making such studies.

Newman's (16) investigations on the star fish and the Texas armadilla as well as his more recent studies of twins, point unquestionably to the fact that there are 2 types of twins. The identical or monozygotic twins arise from the splitting of a single zygote while the fraternal or dizygotic twins arise from the simultaneous development of two zygotes. The psychological studies of twins beginning with that of Galton (4) in 1883 also give evidence of the two types of twins, in that they show a greater degree of resemblance in both physical and mental traits in identical twins than in fraternal twins. Thorndike (19) in 1905 disputed this fact. The later investigations of Merriman (14), Lauterbach (12), Gesell, (5, 6), Muller (15) and Wingfield (22) however have all supported the theory of the monozygotic origin of identical twins.

This investigation, though undertaken primarily to compare language development in twins with that in single children, also obtained sufficient information in regard to the twins studied to determine fairly accurately whether or not they were identical or fraternal twins. With these data at hand, the three types of twins, identical, like-sex fraternal and unlike-sex fraternal were compared as to resem-

[1] From the Institute of Child Welfare, the University of Minnesota. The Development of Language in Twins, Part I, A Comparison of Twins and Single Children appeared in Child Development (Vol. 3, No. 3). It reported the language development of 80 pairs of 2 to 5 year old twins and compared their development with that of the single children reported by D. A. McCarthy (13) in The Language Development of the Preschool Child. McCarthy's method and technique were repeated throughout. The tables of Part 1 and 2 are numbered continuously.

blances and differences in language attainment, mental test performance and certain physical characteristics.

Subjects

Eighty pairs of twins, 20 at each age level, 2, 3, 4, and 5 years, were selected on the basis of sex and occupational class. Like-sex twins were selected in preference to unlike-sex twins in an effort to obtain a larger number of identical twins in the group. Table 5,[2] shows the distribution of cases by age, sex and type of twin.

The percentage of both identical (23.75) and unlike-sex twins (28.75) is low for a representative sampling of the twin population. The like sex fraternal group is proportionately high.

Procedure

Information in regard to the development, likenesses and differences of the twins was obtained largely by means of a questionnaire. This was filled out in consultation with the mother at the same time that the language record was obtained.

Information about the family included parents' birthplaces, education, and occupation; names, and ages, and age of talking of other children; foreign language spoken in the home; policy of the family with regard to speech of the twins; age, sex, and speech of the twins' playmates; leadership and emotional habits of the twins; and whether the family considered them identical.

Specific information obtained on each twin included physical defects, sensory handicaps, serious illnesses, age of walking, talking, first tooth, handedness, thumb sucking, and other nervous habits, play interests, self-help in eating, dressing and toilet habits, and hair and eye color.

In addition to this information records were obtained, where possible, from the hospital or physician, as to the number of placentae reported at the delivery of the twins. Later, when the question arose as to the possible relationship of prematurity of birth to the apparent mental retardation of the twins, a questionnaire was sent to the mother, asking for the following information: Order of birth of the twins, whether or not the twins were born at full term and if not how much they varied from it, whether or not twinning had appeared in any of the relatives of the mother or the father. Seventy of the 80 parents, or 87.5 per cent replied to this questionnaire.

TABLE 5

Distribution of cases by age, sex and type of twin

TYPE OF TWIN	2 YEARS		3 YEARS		4 YEARS		5 YEARS		TOTAL	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Pairs	Per cent
Like sex identical	8	10	2	4	2	6	4	2	19	23.75
Fraternal	8	6	10	8	12	10	10	12	38	47.50
Unlike sex	4	4	8	8	5	5	6	6	23	28.75

[2] Tables are numbered consecutively from Part 1.

THE MENTAL DEVELOPMENT OF THE TWINS

The language retardation of the twins, evident in every method of analysis, suggests at once, the possibility of a similar mental retardation. Merriman was the first to use the present day intelligence test as a device for measuring mental ability of twins and so he was the first one to report I.Q.'s on a large group. Although he found the mean I.Q. of 105 pairs to be 96, he assumed that the slight retardation was due to selection of cases and was not to be interpreted as indicating mental inferiority of twins as a whole. Wingfield (22) on the contrary, concluded from his study, that twins were from 1 to 2 per cent below average in intelligence.

INTELLIGENCE OF THE TWINS

The twins of the present study were given the Minnesota Pre-school Scale[3] as described in Part 1. Test scores were obtained on only 123 of the 160 children. In a few more cases, tests were attempted but a satisfactory test was not obtained. The remainder of the group failed to coöperate to the extent of allowing the tests to be given. The range of I.Q.'s for the twin group was from 59 to 138.

Table 6 shows the mean I.Q.'s by age and sex of the twins and singletons.

It may be seen, as has been pointed out previously, that the twin group is consistently below average, with the exception of the two year old and five year old girls. The singleton group, on the contrary, are slightly superior, except at the three year age group which is approximately average. The tests used in the two instances were not the same. The singletons were given the Kuhlman-Binet test and the twins were given the Minnesota Pre-school Scale (9). However this scale is composed largely of the individual tests from the Kuhlman and Stanford-Binet tests; hence the actual items of each test do not differ greatly. Boys are inferior to girls at every age in both groups, except at three years. Since the selection of the two groups is so nearly identical, the evidence points rather directly toward slight inferiority of the twin

TABLE 6

Mean I.Q. of twins and singletons by age and sex

C.A.	TWINS					SINGLETONS (MC CARTHY)		
	Boys		Girls		All—Mean I.Q.	Boys—Mean I.Q.	Girls—Mean I.Q.	All—Mean I.Q.
	Number of cases	Mean I.Q.	Number of cases	Mean I.Q.				
years 2	14	89.0	11	103.0	95.0	102.4	109.4	106.9
3	15	95.0	18	93.0	94.0	100.5	97.7	99.3
4	18	90.0	17	92.0	91.0	101.8	103.8	103.8
5	14	95.0	10	101.0	98.0			

[3] This scale was in the process of standardization at the time this investigation was made.

group in general intelligence as it was measured.

Not only are the upper occupational groups superior to the lower occupational groups in each cases, but the lower occupational group of singletons is superior to the upper occupational group of twins. A similar situation was apparent in regard to mean length of language response. The slight differences in the percentage of each population, taken from the upper and lower occupational groups, favors the twin group. Exactly 50 per cent of the twin group fall in the three upper groups as compared with 47.1 per cent of the singleton group.

The most interesting evidence in regard to the intellectual inferiority of twins may be seen by a comparison of the findings of the various twin studies. (See table 7) Here the data from the Wingfield, Freeman[4] and Merriman studies have been assembled and to some extent reworked, from their original data, to get the desired means. This group of studies, including the present study, represent a total population of 737 twin children of 368.5 pairs. The range in age is from two to about sixteen years. The intelligence tests used have been standard tests. Only one mean I.Q. in the table is as high as 100 or above, and that is for the 50 pairs of identical twins examined by Freeman. In addition to those data, the Lauterbach data give a mean I.Q. of 95 for that twin group. This adds about 200 pairs of twins to the population considered, making a total of 568 pairs. The mean I.Q. for this entire group of 568 pairs of twins is 96.3. Such a sampling as this, showing consistent mean I.Q.'s from 1 to 6 points below the average I.Q. of 100, for the population as a whole, is surely sufficient evidence to confirm Wingfield's conclusion, that twins are, as a group, slightly below the average in intelligence as measured.

TABLE 7

Mean I.Q. of like-sex and unlike-sex twins as found by the different investigators

	DAY		WINGFIELD		FREEMAN		MERRIMAN		TOTAL	
	Number	I.Q.	Number	I.Q.	Number	I.Q.	Number	I.Q.	Number	I.Q.
Like sex	88	93.5			200	98.8			288	97.2
Identical	27	99.7	90	99.0	100	101.6	44	98.0	261	99.9
Fraternal	61	90.8	62	92.9	100	96.1	90	96.2	313	94.5
Unlike sex	35	96.2	52	98.6			76	94.7	163	96.3
All fraternal	96	92.8	114	95.7			166	95.5	376	94.9
All twins	123	94.3	204	97.2	200	98.8	210	96.0	737	96.8

COMPARISON OF THE INTELLIGENCE OF IDENTICAL LIKE-SEX

Fraternal and Unlike-sex twins

Dr. Freeman in making a preliminary report of the twin study being conducted at the University of Chi-

[4] Investigation now under way in collaboration with Newman and others at University of Chicago. These figures came from mimeographed notes presented by Dr. Freeman at a lecture.

cago, called the attention of the writer to the possible differences in mean I.Q. between identical and fraternal twins. In order to obtain such information in regard to the groups studied, by the other investigators, their original data were worked over. Wingfield and Freeman distinguish their twins as identical, like-sex fraternal or unlike-sex. For the Merriman study, a group denoted, "reported as very similar" in appearance were selected by the writer as the nearest approach to an identical group. The necessary original data for the Lauterbach study could not be obtained. In the Thorndike group, 11 pairs, who from the data on physical measurements appeared to be most nearly alike were selected as possible identical twins. Those data did not give I.Q.'s but the mean deviation from the mean of the composite score, for all tests given, was used as denoting the relative standing of the various types of twins.

Table 7 shows that in every group the identical twins were superior to the fraternal twins and most nearly approached the average of the population as a whole. The total sampling represented is about 130 pairs. Merriman shows a lower mean I.Q. for the identical group than is shown by any other study. It must be remembered, however, that this group is less carefully selected and so very probably includes some fraternal twins. Moreover, his fraternal group very possibly includes some identical twins. The fraternal group, including like and unlike-sex twins, drops from 2.5 to 7.0 points below the identical group in I.Q. This group comprises 238 pairs of twins.

In the Thorndike data the differences are in the same direction. (See table 8.) The fraternal group score slightly below the mean for the entire group and the identical twins score considerably above this mean.

If the data presented by these various studies are on a representative sampling of twins, the consistency of the findings is evidence of a real difference in intelligence between identical and fraternal twins. The cause for such a difference brings up biological problems of great interest. Two of the factors suggested, as possibly entering into such a difference, are the mean occupational class represented by each group and the question of prematurity. Such data were available only for the twins of this study and are presented in table 9.

TABLE 8

Mean deviation score of twins (Thorndike)

	NUMBER OF CASES	MEAN DEVIATION SCORE
Like sex:		
Identical	22	+701.77
Fraternal	34	−26.35
Unlike sex	14	−126.57
All fraternal	48	−55.58

The occupational class differences favor the identical twins by .3 of an occupational class. It would be interesting to know whether or not the tendency for twins to develop from a single zygote is more prevalent among the upper classes than in the lower classes. The sampling is too small in

the present study to make sure that this difference is not due to selection. It is to be hoped, that in the future investigators will note the occupational class of the subjects.

The Goodenough (8) evaluation of the Kuhlman-Binet test was based upon 300 cases very carefully selected from the standpoint of occupational class. Goodenough says, "The differences between the mean I.Q. earned on the first examination by the children of parents belonging to the professional classes, and the corresponding rating for the children of day laborers amounts to approximately one and one-fourth standard deviations of the total distribution of I.Q.'s for the entire group." Goodenough's findings in this regard are in close agreement with the results of the army intelligence tests and those of Haggerty and Nash (11) based upon an examination of 6,688 New York State School children. The difference of .3 of an occupational class found in this study between the identical and fraternal groups, is no doubt a factor in causing the differences found between these groups in I.Q. It is, nevertheless, a question as to whether it is entirely accountable for the difference.

TABLE 9

Mean I.Q., occupational class and period of gestation like-sex and unlike-sex twins

TWINS	MEAN I.Q.	OCCUPATIONAL CLASS	PERIOD OF GESTATION
			weeks
Like sex:			
Identical	99.7	3.4	36.1
Fraternal	90.8	3.9	38.5
Unlike sex	96.2	3.5	39.9
All fraternal	92.8	3.7	39.2

It is a well known fact that twin births constitute a large proportion of the premature births. This is one factor in their high rate of mortality at birth. Capper (1) in an investigation of 437 immature infants, found that 72 per cent of them were born prematurely. Fourteen per cent of those born prematurely were twins. The mean period of gestation for 68 pairs in the present study was 38.4 weeks or 269 days. This is not apparently a startling variation since Capper says, "In obstetrics a mature infant is one born at term, i.e., at the end of from 270 to 290 days, irrespective of the degree of the development of the baby."

Table 9 shows that the identical group have the lowest mean period of gestation and are approximately one month premature. They are, however, the group with the highest mean I.Q. A correlation (Pearsonian r) of $+.03 \pm .067$ was obtained between I.Q. and the period of gestation for 102 twins. The correlation between birth weight and the period of gestation was found to be $-.44 \pm .054$ and between birth weight and I.Q. $+.05 \pm .062$. Since there is little relationship between, either the period of gestation and I.Q. or the birth weight and I.Q., prematurity cannot be a very significant factor in causing the differences in I.Q. between identical and fraternal twins. Gesell (7), in discussing the growth of the premature infant, says, "The maturation of the

central nervous system is perhaps least affected by the condition of prematurity. The head of the premature infant continues to grow in size at a relatively normal rate, even when his general bodily development is distinctly subnormal."

EFFECT OF LANGUAGE UPON THE MENTAL TEST SCORE

Thirteen of the 29 individual tests included in the Minnesota Pre-school Scale at this time, required a verbal response. Since the twins as a group were 6 points below average in I.Q., the question arose as to whether the intelligence test score had not been reduced by the twins' handicap in language. In order to check this point, the four year old group, which had a lower mean I.Q. than any other age group (91.), were matched with a control group of single children. Mental tests had been obtained on 35 of the four year old twins. These were matched as closely as possible with other cases, who had been given the same test. They were matched in regard to total test score, chronological age at time of testing, sex, and occupational class.

Table 10 shows the means of the various aspects matched, which were found for the two groups. It also shows the mean raw scores and percentage scores, determined separately, for the 13 verbal and the 16 non-verbal test items. These could not agree much more closely. It seems to the writer to show that the Minnesota Scale requires a minimum of language, as it was planned to do. At least, single children, who it has already been pointed out, have superior language ability, did not in this instance use their language ability any more effectively than did the twins. The language retardation of these four year old twins, does not seem to have been a factor in reducing the total test score and thus lowering the I.Q. It may be pointed out, however, that the test did not give an opportunity for the maximum use of language.

TABLE 10

Mean intelligence test score, age and occupational class of four year old twins and control group

	TWINS—MEANS	SINGLETON (CONTROLS)—MEANS
Occupational class	3.0	4.1
Chronological age*	4–2–3	4–2–7
Total test score	103.37	103.00
Raw verbal score	47.4	47.0
Raw non-verbal score	56.0	56.6
I.Q.†	90.7	93.6
Percentage verbal score	46.3	45.4
Percentage non-verbal score	53.7	54.6

* C.A. is stated in years, months and days.

† The apparent discrepancy in the differences found in I.Q., although the total test score and C.A. are the same is due to the fact that as the Minnesota Scale was still in process of standardization, the raw point score had not yet been transferred into equivalent scale values.

The relation between the language development and intelligence may be seen by the series of correlations presented in table 11. The Pearson product moment method of correlation was used.

It may be seen, that the McCarthy four year old singletons show a small positive correlation between length of

response deviation from the mean and I.Q. whereas the twins, of this age, show practically no correlation. Twins at 2, 3, and 5 years, however, show similar correlations of +.43 between mean length of response and I.Q. The lower, or practically zero, correlation of the 4 year old group, in this instance, is probably affected by the smaller standard deviation of I.Q.'s. The standard deviations of the distribution of I.Q.'s are as follows: 2 years 14.75, 3 years 12.83, 4 years 9.19, 5 years 14.00.

The four year old group, for some reason, shows a fairly high negative correlation (−.57) between the total score on the intelligence test and the percentage of verbal score. Both the control group of singletons and the five year old twins show approximately a negative correlation between these same scores. It appears to be true, for these four year old twins, that

TABLE 11

Correlations between measures of language development and measures of intelligence

TRAITS CORRELATED	TWINS			SINGLETONS		
	Number of cases	r	P.E.	Number of cases	r	P.E.
I.Q. and mean length response 2 years	25	+.42	±.11			
I.Q. and mean length response 3 years	33	+.43	±.09			
I.Q. and mean length response 4 years	35	−.07	±.11			
I.Q. and mean length response 5 years	30	+.43	±.10			
Four-year age group:						
I.Q. and verbal score	35	+.40	.10			
I.Q. and non-verbal score	35	+.64	.07			
Mean length response and verbal score	35	−.04	.11			
Mean length response and non-verbal score	35	−.13	.11			
Length of response deviation from mean and I.Q.	35	−.08	.11	20	+.37	±.13*
Verbal and non-verbal scores	35	+.63	±.07	35	+.61	±.07†
Total test score and per cent verbal score	35	−.57	±.08	35	+.09	±.11†
Total test score and per cent non-verbal score	35	+.55	±.08	35	+.08	±.11†
Five-year age group:						
Total test score and per cent verbal score	30	+.01	±.12			

* McCarthy singletons.

† Control four-year old singletons.

the lower the proportion of verbal score, the higher the total test score although such is not the case for five year old twins. It is open to question then, as to whether the relationship found in the four year old twins is to be interpreted as typical for twins in general, or whether it may be attributed to some phenomenon of this particular group of twins or what is perhaps more probable, of the test used.

COMPARATIVE RETARDATION OF TWINS IN LANGUAGE DEVELOPMENT AND GENERAL INTELLIGENCE

In order to compare the language retardation of the twins with their retardation in general intelligence, the mean length of response was converted into a language quotient. To do this the mean length of response of singletons for each age group was assumed as 100 or average. This involves error, since the McCarthy study is based upon only 20 children at each age. However, no other data were available.

The language age was determined by the following formula:

$$S : \text{"C.A."} :: T : X$$

"S" = the mean length of response for the singletons of a given age.[5]

"C.A." = the given age.

"T" = the mean length of response of the twins for the given age.

"X" = the language age.

$\frac{X}{C.A.}$ = the language quotient (L.Q.).

Table 12 shows the comparative retardation of twins in language development and general intelligence in terms of L.Q. and I.Q. The language retardation is so significantly greater, that factors other than "below average general intelligence" must be responsible for it. The language quotient decreases rapidly as age increases in spite of the fact that the intelligence quotient does not. Nevertheless, this increasing difference is not accompanied by a decreasing relationship between the two factors since the correlations between mean length of response and I.Q. show no consistent trend with age.

The twin situation differs markedly from the situation of a single child in but one respect and that is companionship. This difference begins in fetal life and is an environmental factor. It will have to be left for the biologists to tell whether or not, the development of two embryos may limit or reduce the inherited traits, and in what particulars. The differences between the mental ability of identical and fraternal twins suggests a nutritional difference in embryo. Since there are twice as many fraternal twins as identical twins, they would tend to pull down the mean I.Q. for twins as a whole, keeping it below 100. Aside from the possible inheritance of imperfect physiological factors concerned with speech, it seems more probable to expect the environmental factor to

[5] This figure (4.7) at 5 yrs. was taken from the Smith investigation. Her mean lengths of response at all ages agreed closely with the McCarthy findings. Smith, M.E. An Investigation of the Development of the Sentence and the Extent of Vocabulary in Young Children. Univ. of Iowa, Studies in Child Welfare, 3, No. 5. Iowa City, 1926. 92 pp.

have a limiting effect. One surely could not learn as much or as rapidly, from companionship with an individual so nearly on his own plane, as from one who was in advance. Satisfactions from this companionship may be adequate to the twin, whereas the single child may be motivated to gain his satisfactions from a wider field.

THE RESEMBLANCE OF THE TWINS

Basis for the selection of identical twins

The information obtained about the placentae proved to be too indefinite, in most cases, to be reliable. Likeness in hair and eye color and general appearance were found to be a more adequate basis for determining the identical twins. There were but five doubtful cases. One pair of girls, were finally classed as identical, as the only difference in them was a slight difference in size. The other four were all classed as fraternal due to slight differences in appearance.

The proportion of each type of twin having both identical hair and eyes is shown in Table 13. In approximately 50 per cent of the entire group these were similar although in only about 24 per cent, the identical group, was the appearance of the children also identical.

The development of the twins

The prematurity of the twins was discussed in connection with its relation to mental development. The mean birth weight was 2595.46 grams with a mean period of gestation of 269 days. The birth weight figures were taken from the mother's report. The hazard of this birth weight may be seen by Capper's statement, that of the 437 records of immature infants 145 weighed from 2,001 to 2,500 grams. The mortality of this group was 32 per cent by 6 years. The average birth weight for the population as a whole is between 3000 and 3500 grams.

Of the 68 pairs who had older brothers and sisters 42 per cent were reported by the mother as developing

TABLE 12

Comparative retardation of twins in language development and in general intelligence

	MEAN			
	2 years	3 years	4 years	5 years
Intelligence quotient	95.0	94.0	91.0	98.0
Language quotient	83.5	73.7	68.2	68.0

TABLE 13

The proportion of twins having identical hair and eyes

	NUMBER OF PAIRS	PER CENT OF TWIN GROUP	PER CENT OF LIKE HAIR AND EYE GROUP
Identical	18	94.7	46.2
Like sex fraternal	15	39.5	38.4
Unlike sex	6	26.1	15.4
All twins	39	48.75	

more slowly physically than the other children, 46 per cent were reported as developing about the same and 12 per cent faster than the older siblings. In the three twin groups, 35 per cent of the identicals developed more slowly than older siblings, 45 per cent of the fraternals were slower, and 39 per cent of the unlike sex.

The development of the twins in learning to talk and walk, and in cutting the first tooth is shown in table 14. The identical group shows a slight minus deviation from the mean in age of talking and walking but a plus deviation (.3) in age of cutting the first tooth. The like sex fraternal group show a plus deviation from the mean in all three activities. The unlike-sex twins show a plus deviation from the mean in age of talking but a minus deviation in the age of walking and of cutting the first tooth. The 68 pairs of twins having older siblings, show a mean age of talking approximately one month (.96 mos.) later than the mean age of talking for the older siblings. These data are based on the mother's report of the ages at which the children first talked, and are therefore subjective. Although the difference lies in the same direction as the language retardation of the twins found throughout this study the subjectivity of the data and the small number of cases did not warrant further analysis.

Both the twins and their siblings were late in beginning to talk. In consideration, however, of the subjectivity of the data, the fact that the twins began to talk at a later age than their siblings seems to be more significant, in denoting their retardation, than is the comparison with the norm.

The twins appear average in respect to age of walking according to Gesell's norm. The twins also cut their first teeth within the average time stated, which is 6 to 9 months.

TABLE 14

Mean age of beginning to talk, walk, and cut teeth

	TALKING		WALKING		CUTTING TEETH	
	Mean age	Deviation —mean	Mean age	Deviation —mean	Mean age	Deviation —mean
	months		*months*		*months*	
Identical	16.3	−1.7	14.0	−.3	8.4	+.3
Like sex fraternal	17.2	+.2	15.1	+.2	0.4	+1.3
Unlike sex	18.2	+1.2	14.8	.1	7.8	−.3
All twins	17.0		14.0		8.1	

Emotional resemblance. Sixty per cent of all the twins were reported as being different emotionally. However, only 32 per cent of the identical twins were thought to differ in this respect as compared with 72 per cent of the like sex fraternals and 65 per cent of the unlike-sex twins.

Leadership. In 75 per cent of the cases, one twin was reported as showing the qualities of a leader more than the other twin. This was reported as being the case in 37 per cent of the identical twins, 87 per cent of both the

and unlike-sex fraternal twins. unlike-sex twins the girl was l as being the leader approxi- twice as often as the boy.

'edness. The handedness of ns is based upon the mother's ınd not upon a test of handed- Thirty-four or 21.0 per cent ıe twins showed some tendency handedness. Table 15 shows portion of each type of twin, re right-handed, left-handed or xtrous.

ıe 34 twins having a tendency

one an unlike-sex pair, and one a pair of identical boys.

Newman's theory of the "asymmetry mechanism" and its effect on the degree of likeness found between identical twins assumes that handedness is genetically determined. If this is true, one would expect to find the percentage of left handedness in twins of dizygotic origin equal to that in the population as a whole or about 4 to 5 per cent. Of the 122 fraternal twins in this group, 15 or 12 per cent were positively left handed and twenty-

TABLE 15

Handedness in twins

	PROPORTION OF ALL TWINS						PROPORTION OF TWINS WITH LEFT-HANDED TENDENCY	
	Right		Left		Both			
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
:								
cal	29	76	4	11	5	13	9	26
·nal	65	86	7	9	4	5	11	32
ıex	82	80	8	17	6	13	14	42
s	126	79	19	12	15	9		

the left hand, 21 or 62 per cent ɔys and 13 or 38 per cent were Twenty-four per cent of the al twins showed a tendency to e left hand although only 11 ıt were positively left-handed. en per cent of the like-sex al group showed such a tend- lthough only 9 per cent were ely left handed. Thirty per f the unlike sex twins inclined ı direction with seventeen per lefinitely left handed. There ınly three pairs in which both tended to be left handed. One se was a pair of fraternal girls,

five or 20 per cent showed some tendency in that direction. Some other factor peculiar to the twin situation must be operative to increase the percentage to this extent. These data are not sufficiently reliable either in number of cases or in the method of determining handedness to draw any definite conclusions. In general, however, these findings are in agreement with those reported by others. Lauterbach found about 19 per cent of the two hundred pairs of twins were left handed. He did not distinguish any group as identical twins; however, of his 63 pairs of unlike sex twins about

seven per cent were left handed. Newman summarizes the findings of Siemons (18), Weitz (21) and Dahlberg (2) on identical twins. Of the 124 pairs of identical twins in these investigations, 16.5 per cent were left handed. Dahlberg also studied 128 pairs of dizygotic twins and found 7 per cent to be left handed. Verschuer (20) found 16 per cent of 158 identical twins left handed and 13 per cent of 76 fraternal twins. Newman found 50 per cent of his 100 identical twins showing some left handedness and 15 per cent of the 100 fraternal pairs. Only 6 per cent of the fraternal group were very positively left handed. Gesell agrees with Newman that handedness is genetically determined. The fact that left handedness is sometimes a familial trait and is so frequent in twins he finds as a basis for this theory. It seems to the writer that the theory of intrauterine position as a factor causing left handedness, is supported by the frequency of left handedness in twins, especially by the fact that dizygotic twins show a higher percentage than the population as a whole.

Resemblance of the twins in general intelligence. Tables 16 and 17 show the correlations obtained for each age group and each type of twin, in the various measures of language development and in I.Q. The Pearson produce moment correlation was used throughout. In correlations between like-sex twins a shortened method of the double entry Pearsonian correlation as developed by Goodenough[6] was used.

[6] Goodenough, F. L., & Anderson, J. E. Experimental Child Study p. 239–243. Century Co., 1931.

The resemblance of the twins in general intelligence ($r = +.72$) is three to six points lower than that found by other investigators with one exception. The Wingfield data as reworked by the writer give an $r = +.55$ for all twins which is only a little higher than the resemblance given for siblings of $+.50$.

There are no consistent changes with age in this relationship. The correlation coefficient of $+.85$ of the two year olds is higher than the others, probably because nine of the twenty pairs of twins at this age are identical twins. The low correlation of the four year olds ($+.37$) appears to be due to the small distribution of the I.Q.'s ($\sigma = 9.31$). In agreement with the findings of Thorndike, Merriman, Lauterbach and Wingfield the coefficients of correlation for the older twins are not consistently greater than those for the younger twins.

The identical twins show a very close resemblance in general intelligence as shown by the correlation coefficient of $+.92$. Wingfield found a correlation coefficient of $+.90$ for this relationship and the writer of $+.84$ on Wingfield's data. The like-sex fraternal and unlike-sex groups show coefficients of $+.61$ and $+.73$ respectively. In the Wingfield data as reworked, these coefficients are $+.21$ and $+.29$. In both instances these appear to be reversed, since like-sex twins as a rule show closer resemblance than twins of unlike sex. This may be due in part to the smaller distribution of I.Q.'s in the case of both like sex fraternal groups. Why the Wingfield coefficients fall so far below that expected for twins is hard to determine. The sampling

TABLE 16

Correlations between twins at each age in language development and in I.Q.

	2 YEARS*			3 YEARS			4 YEARS			5 YEARS			ALL TWINS—AVERAGE r
	r	P.E.	σ	r	P.E.	σ	r	P.E.	σ	r	P.E.	σ	
Mean length response	+.59	±.10	0.45	+.26	±.14	0.6	+.23	±.15	0.9	+.50	±.11	1.2	+.39
Complete sentences	+.48	±.12	20.1	+.58	±.10	11.3	−.13	±.15	8.7	−.18	±.15	7.9	+.19
Incomplete sentences	+.51	±.12	15.6	+.53	±.11	11.3	−.22	±.14	8.5	−.15	±.15	8.0	+.14
Functionally complete but structurally incomplete	+.60	±.10	26.0	+.44	±.12	19.2	+.24	±.14	17.6	+.39	±.13	22.1	+.42
Simple sentences	+.21	±.14	11.3	+.34	±.13	15.6	+.00	±.15	11.3	+.38	±.13	12.9	+.23
Adapted information	+.49	±.11	22.3	+.06	±.15	16.0	+.09	±.15	14.6	+.22	±.14	20.5	+.21
Naming	+.57	±.10	16.0	+.44	±.12	12.9	−.33	±.13	11.6	+.55	±.10	18.2	+.31
Remarks about situation	+.36	±.13	11.0	+.72	±.07	13.6	−.11	±.15	11.7	+.21	±.14	14.1	+.29
Emotionally toned response	+.53	±.11	21.7	+.11	±.15	12.4	+.42	±.12	10.7	+.69	±.08	15.4	+.44
Questions	+.00	±.15	2.9	+.03	±.14	7.8	−.06	±.15	8.4	+.58	±.10	7.8	+.14
Answers	−.11	±.15	14.4	+.40	±.13	11.7	+.23	±.14	15.7	+.55	±.10	21.9	+.27
I.Q.	+.85	±.05	14.0	+.70	±.08	11.2	+.37	±.14	9.3	+.77	±.07	14.3	+.72† ±.042

* There were 20 pairs at each age except for I.Q. correlations. Here there were 12 pairs at 2 years, 16 pairs at 3 years, 17 pairs at 4 years, and 15 pairs at 5 years.

† This r is not an average but was plotted for 60 pairs twins, σ 12.52.

TABLE 17

Correlation between twins in language development and in I.Q.

	IDENTICAL (19 PAIRS)				LIKE SEX FRATERNAL (38 PAIRS)				UNLIKE SEX (23 PAIRS)				
	Raw	Age constant	P.E.	σ	Raw	Age constant	P.E.	σ	Raw	Age constant	P.E.	Boy	Girl
	r	r			r	r			r	r		σ	σ
Mean length response	+.89	+.80	±.04	1.21	+.42	+.28	±.10	1.1	+.63	+.40	±.12	0.8	1.1
Complete sentences	+.60	+.60	±.07	14.6	+.34	+.29	±.10	13.5	+.33	+.20	±.13	15.0	11.0
Incomplete sentences	+.53	+.53	±.08	14.4	+.36	+.31	±.10	9.4	+.31	+.22	±.14	14.5	11.2
Functionally complete but structurally incomplete	+.78	+.72	±.05	24.0	+.34	+.31	±.10	22.5	+.52	+.54	±.10	17.6	24.6
Simple sentences	+.64	+.51	±.08	15.4	+.52	+.44	±.09	14.4	+.22	+.18	±.14	12.7	18.8
Per cent total nouns	+.81		±.05	19.0	+.60		±.07	13.7	+.70		±.07	12.5	17.0
Per cent total verbs	+.67		±.08	10.3	+.19		±.10	9.11	+.48		±.10	6.7	11.4
Per cent total pronouns	+.59		±.10	8.9	+.47		±.09	8.8	+.44		±.11	7.0	7.5
Per cent total interjections	+.58		±.10	13.3	+.94		±.01	9.7	+.41		±.12	8.4	4.9
Ego-centric responses	+.56	+.52	±.08	13.4	+.02	−.04	±.10	11.9	+.58	+.53	±.10	15.5	14.4
Adapted information	+.36	+.29	±.10	21.3	+.27	+.25	±.10	18.4	+.56	+.51	±.10	16.4	20.7
Naming	+.39	+.38	±.09	13.6	+.19	+.18	±.11	13.6	+.61	+.61	±.09	16.7	18.9
Remarks about situation	+.52	+.44	±.09	16.1	+.29	+.23	±.10	23.9	+.63	+.61	±.09	11.2	13.8
Emotionally toned response	+.60	+.54	±.08	19.4	+.63	+.60	±.07	17.4	+.22	+.16	±.14	11.8	10.4
Questions	+.47	+.43	±.10	4.6	+.10	+.01	±.11	7.2	+.40	+.33	±.13	9.6	8.4
Answers	+.09	+.07	±.11	17.3	+.48	+.45	±.09	17.5	+.25	+.24	±.13	10.7	16.3
Mean coefficients		+.53				+.31				+.41			
I.Q.*	+.92		±.03	12.9	+.61		±.08	10.1	±.73		±.08	12.8	14.8

* For these correlations with I.Q. there were only 13 pairs of identical twins, 30 pairs of fraternal twins and 17 pairs of unlike-sex twins.

is relatively small, however, in all of these groups both in the Wingfield investigation and the present investigation.

The mean difference in I.Q. between the various twin groups is shown in Table 18.

As would be expected, the pairs of identical twins show consistently less difference in I.Q. than the pairs of fraternal twins. This corresponds to their closer resemblance in physical traits. Moreover, the pairs of like sex fraternal twins show less mean difference in I.Q. than the unlike sex twins in spite of the fact that the correlation between the I.Q.'s of unlike sex twins is greater than that between like-sex fraternals. This emphasizes the fact that correlations based upon different dispersions of measures are not comparable. It will be remembered that this like-sex group had a smaller standard deviation than the unlike sex group.

Resemblance of the twins in measurements of language development. When considered from the standpoint of age groups, the correlation coefficients present negative, zero and positive relationships. In general the two year old group show the higher correlations and, as in the case of the I.Q.'s, this may be due largely to the large number of identical twins at two years. In Questions and Answers, both of which were found to increase considerably with age. Coefficients of the five year old of +.58 and +.55 show much greater relationship between the twins than those at any other age. Over the age period at which rapid change is taking place in any function, higher relations are found between the members of the pairs. In the use of complete and incomplete sentences the two and three year olds show coefficients around +.50 whereas a slight negative relationship appears at four and five years. There is not sufficient consistency in the changes of these correlation coefficients from age to age to show either that the twins grow more or less alike with age or even that their resemblance remains about the same.

The resemblance between twins of each type in measures of language development are also quite variable. In mean length of response and the phases of the construction of sentence analysis and word analysis with the exception of the percentage of interjections, identical twins show a consistently higher correlation than do the fraternal groups. In the functional

TABLE 18

Mean difference in I.Q. of twins

	DAY		WINGFIELD (178)		NEWMAN (114)	
	Number of pairs	Mean difference, I.Q.	Number of pairs	Mean difference, I.Q.	Number of pairs	Mean difference, I.Q.
Identical	13	3.40	45	6.23	50	5.3
Like sex fraternal	30	6.83	70	8.5		
Unlike sex	17	10.18	26	12.0		

analysis, however, this is not true. In fact, with two exceptions (emotionally toned responses and answers) the unlike-sex group show closer resemblance. The phases of the functional analysis, because they are functional in nature might be expected to show less relationship between members of a pair than those, such as the phases of the construction analysis, which are of a developmental character.

The unlike-sex group show a correlation coefficient higher than the like-sex fraternal group in the functionally complete but structurally incomplete responses, the percentage of total nouns and percentage of total verbs. They show closer resemblance than either the like-sex fraternals or the identical group in ego centric responses, adapted information, naming, and questions. In all of these phases, however, the unlike-sex group show a larger distribution of measures, than the other groups, which in part will account for this.

The average resemblance in these measures of language development for identical twins is +.53, for like-sex fraternal twins, +.31 and for the unlike sex twins +.41.

Relation of certain environmental factors to the language development of the twins. An effort was made to find out how frequently stories were read or told to the twins in order to see if this affected in any way their language development. The estimate the mother made as to the frequency of reading stories was, of course, very rough. These estimates grouped themselves into four categories as follows:—the children were read to daily, several times a week, occasion-

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reported that members of the family imitated the speech of twins.

Twinning in the ancestry

The information obtained in regard to twinning in the ancestry was not sufficiently specific to show exact relationships. Of the 68 pairs of twins from whom this information was obtained, 68 per cent had relatives who were twins; 26 per cent on the mother's side, a similar percentage on the father's side, and 16 per cent had twin relatives on both sides of the family. There was no striking difference in this respect between identical and fraternal twins with the exception that more of the former had twin relatives on both sides of the family (33 per cent). These data are based on so few cases, however, that such a difference is probably due to selection. Moreover, since comparable data for the general population are not available the significance of these percentages is highly uncertain.

SUMMARY

The results of these data may be summarized as follows:

1. Twins are below average in intelligence test performance. The 568 pairs of twins represented by the Merriman, Lauterbach, Freeman, Wingfield and present study had a mean I.Q. of 96.3.

2. Fraternal twins were found to be from 2 to 7 points below identical twins in general intelligence in the Merriman, Freeman, Wingfield and present investigations.

3. The language retardation of the twins did not reduce the total test score of the intelligence test. When the mean score on the verbal test items of the intelligence tests of the twins was compared with that of the control group they were found to be equal.

4. The language retardation of the twins in terms of "language quotient" is very much greater than is their retardation in general intelligence in terms of I.Q.

5. Identical twins were found to resemble one another much more closely than fraternal twins. A correlation coefficient of +.92 was found for identical twins in general intelligence as compared with +.61 and +.73 for the like-sex and unlike-sex fraternal twins. The mean coefficient of correlation for the identical twins in the various phases of language development was +.53 as compared with +.31 and +.41 for the like-sex and unlike-sex fraternal twins.

6. In agreement with the other studies the older twins showed about the same resemblance in the traits measured as the younger twins.

7. The twins of the present study, on the average, began to talk 1 month later than their older siblings.

8. They were not found to be retarded in age of beginning to walk or in the appearance of the first tooth, when compared with norms for the general population.

9. Twenty-one per cent of the group showed a tendency to be left-handed. This is similar to the findings of other studies of twins.

10. Sixty per cent of the twins differed emotionally although only 32 per cent of the identical twins were thought to differ in this respect.

11. In 75 per cent of the twin pairs,

1 was thought to be the leader. In unlike-sex pairs the girl was thought to be the leader twice as often as the boy.

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The Development of Logical Selection in Word Meaning Among School Children[1]

F. R. Noffsinger and C. M. Louttit

THE Indiana Mental Survey Test, Schedule D, contains as one of its sections a list of ten words, each followed by a group of words more or less closely related. Of these words two are always associated with the key word, while the others are not. An analysis of this particular item might afford interesting data on the growth of logical selection in children. A large number of marked papers were available from a study made some years ago by Pressey (1), so the raw data for such an analysis were at hand.

The pertinent section of this test is Number 2, Logical Selection, the contents of which are here reproduced with the two correct responses indicated in italics.

INDIANA MENTAL SURVEY TEST, SCHEDULE D

II. Logical selection

Examples

Book: table, pages, shelf, printing.

Chair: arm, cushion, legs, rocker, seat.

1. Cat—fur, house, milk, claws
2. Tree—apples, branches, acorns, roots, flowers
3. Spelling—book, writing, pencil, words, margin, letters
4. School—blackboard, teacher, window, pen, bell, school-house, pupils
5. Store—counter, clerk, cash-register, advertisements, goods, boxes, stove
6. Building—windows, wood, chimney, wall, shingle, roof, stairs, shed
7. Debt—mortgage, creditor, money, lawyer, collector, debtor, bankruptcy
8. Sickness—lameness, death, weakness, hospital, nurse, discomfort, doctor
9. Government—capitol, consul, navy, freedom, king, senate, cannon, tax
10. Friendship—adoration, liking, lover, obedience, imitation, helpfulness, worship

The instructions given to the pupils by the examiner are: "Just below where you have been writing are some words in big letters. Each is followed by a list of other words in small letters. Look at the samples: the first word in big letters is book. What two things in the list following is a book never without? Those 2 words are under-

[1] Publications of the Indiana University Psychological Clinics, Series II, no. 3. The complete tables referred to in this paper are on file at the Psychological Clinic at Bloomington.

lined. Look at the second example. What 2 things in the list following 'chair' is a chair never without? Put a line under each of these two words. Now, attention! In each of the 10 lists, just below, put lines under the 2 words which the word in large letters, at the head of the list, is never without. And just one thing more: do not underline more than two words in any list."

The 2,050 cases used were selected from some 3,500 papers marked by children in the schools of Bloomington, Bedford, Logansport and Jeffersonville, Indiana, and a few other scattered schools of the state. The papers were sorted by age and all the papers were eliminated on which directions had not been followed. From the remainder, the first 100 papers of boys and the first 100 papers of girls at each age were selected with three exceptions. Only 50 papers for each sex at ages eight and eighteen and only 25 papers for each sex at age nineteen were found available. When the cases at each age were arranged according to the score on the complete test, it was found that they closely approached a normal distribution. We feel, therefore, that our subjects were not selected on the basis of ability.

TABLE 1

Significance of sex differences

$\frac{\text{DIFF.}}{\sigma\ \text{DIFF.}}$	PER CENT	NUMBER OF CASES
No difference	14.0	116
0-0.9	30.3	311
1.0-1.9	37.1	295
2.0-2.9	7.3	58
3.0-4.0	1.5	12

Results. If it were possible to consider the sexes together, the analysis of several typical developmental curves would be greatly simplified, therefore it seems wise to consider the sex comparisons at once. As there were 66 words from which the selections were made and there were 12 age groups for each, there is a total of 792 comparisons. For each of these the differences and σ differences of the percentages have been calculated. Table 1 shows the distribution of the $\frac{\text{diff.}}{\sigma\ \text{diff}}$ values.

As is evident, only 1.5 per cent of the comparisons are significant according to the usual criterion that the difference should be at least three times its standard deviation. The 12 cases which are significant are shown in detail in table 2. Seven of these are scattered among 5 of the key words and apparently exhibit no consistent trend. The remaining 5 are all found in relation to the key word FRIENDSHIP. *Liking* is felt to be necessary to friendship by 21 per cent more fourteen-year-old girls than boys, and the significance of this difference is expressed by a ratio of 3.1. One might think of this as a sex difference influenced perhaps by adolescence but at year thirteen the ratio is only 0.3 and at fifteen there is no difference at all. Of nineteen-year-old girls 32 per cent selected *adoration* while no boys selected it. Here again the immediately preceding age shows a very small significance expressed by the ratio of 0.7. *Helpfulness* was selected by 27 per cent more girls than boys and in this case the ratios of the neighboring ages suggest that this may be characteristic. Fifteen-year-olds show

a ratio of 1.2; sixteen-year-olds, of 4.0; seventeen-year-olds, of 2.3; and eighteen-year-olds, of 1.8. At nineteen the ratio is 1.3, but the difference is in favor of the boys, of whom 10 per cent more selected the word. Of all the selections for this key word, that of *lover* is most interesting. At age thirteen there is no difference; for the succeeding ages the differences always show the boys with the greatest percentage selection until age nineteen, when again there is no difference. The significance of the differences are expressed by the ratios: year fourteen, 2.5; fifteen, only 0.2, the difference being only one per cent; sixteen, 3.1; seventeen, 3.0; and eighteen 1.4. It would appear that by late adolescence friendship has more of a sexual significance for boys than for girls. However, the percentage of boys selecting the word at these ages ranges closely about 25, so that a suggestion such as the above cannot be made into a very wide generalization.

TABLE 2

Words showing significant sex differences

KEY WORD	WORD	AGE	DIFF. / σ DIFF.	PER CENT		DIFFERENCE	
				Boys	Girls	Boys	Girls
Store	counter	8	3.0	26	54		28
Store	cash-register	15	3.6	1	14		13
Building	shingle	9	3.2	14	2	12	
Debt	bankruptcy	8	3.2	26	4	22	
Sickness	hospital	9	3.0	6	20		14
Government	senate	15	3.0	40	61		21
Government	tax	18	3.2	68	38	30	
Friendship	*adoration*	19	3.4	0	32		32
Friendship	liking	14	3.1	52	73		21
Friendship	lover	16	3.1	28	11	17	
Friendship	lover	17	3.0	23	8	15	
Friendship	helpfulness	16	4.0	46	73		27

In regard to sex differences in this type of logical selection, it appears that one can safely conclude there are none of significance. Accepting this conclusion as true, we have proceeded with our further analysis on the basis of percentage selection of the total group.

Developmental curves. The data presented in the following discussion are based on the choices made by 200 boys and girls at each age except at ages eight and eighteen, where there were only 100, and at age nineteen where there were only 50 cases. The percentages of children at each age selecting each of the words have been calculated and for each of the 10 key words charts have been drawn to illustrate the changes in selection made with advancing age. The limitations, imposed by journal publication, make it impossible that all of the tables and charts be reproduced. For the purposes of our discussion we have selected 4 key words which illustrate types for

detailed discussion. Reference will be made when pertinent to data from tables not here presented.

The curves for the first 3 key words—CAT, TREE, SPELLING—show that the correct and incorrect responses are not confused even at the lowest ages. The data of table 3 show the percentage choices for the word CAT.

Claws and *fur*, both of which are essential to the concept cat, were marked by about 90 per cent of eight-year-olds and the percentages increased with age. Conversely the non-essential elements, *milk* and *house*, were marked by 10 per cent or less. A similar divergence is to be found in the response to TREE. The correct responses to SPELLING were marked by about 55 per cent of the eight-year-olds and the percentages increased until they reached about 85 at age fifteen. Thereafter there is little increase. Interesting, however, is the response to *writing* which was selected by 40 per cent of the eight-year-olds; the percentages decreased slowly to a minimum at eighteen years of 12 per cent. This is the first instance in the series where a word is included which has a direct bearing on the subject's activity in relation to the key word. For the school child writing is closely connected with the spelling lesson and this is reflected in the relatively high percentage who selected this word as being always associated with spelling.

TABLE 3

Responses to "cat"

AGE	FUR	HOUSE	MILK	CLAWS
8	89.0	10.0	12.0	92.0
9	93.5	5.0	7.0	94.5
10	94.5	3.5	4.5	97.5
11	99.0	1.0	2.0	98.0
12	97.5	2.0	2.5	98.0
13	100.0	0.0	0.5	99.5
14	99.5	0.0	0.5	100.0
15	99.0	0.0	1.5	99.5
16	99.5	0.5	2.5	97.5
17	100.0	0.5	0.0	99.5
18	99.0	0.0	1.0	100.0
19	100.0	0.0	0.0	100.0

The second typical group of curves may be illustrated by the response to SCHOOL, as shown in table 4. Here about two-thirds of the younger children selected *teacher*, and with some depression in the percentage at ages twelve to fourteen, it increased to 82 per cent at age nineteen. The younger children feel, however, that the other essential element of school is the *blackboard*, as also represented by a response of two-thirds of the eight-year-olds. The percentage selecting this word steadily and rather swiftly declines to a minimum of 4 per cent at nineteen years. The other correct response, *pupils*, is selected by only 24 per cent of eight-year-olds but the percentage steadily increases to a maximum of 74 at nineteen years. The same sort of curves are seen in the choice for STORE. *Clerk* is consistently high, *goods* starts low but steadily increases, and *counter* starts high and decreases. Here again, as in response to SPELLING, the words *blackboard* and *counter*, which are important elements in the child's behavior in the school and store situations, are selected as being essential to the concept by the younger children.

A third group of cases are those for BUILDING, DEBT, and SICKNESS, illus-

trated in table 5 by the responses to BUILDING.

These are characterized by the very small percentage selection of the correct words at the younger ages and the subsequent increase and also by the selection of incorrect words by the younger children with a subsequent decrease. For BUILDING, *window* and *chimney* are selected by over 50 per cent of the eight-year-olds; and for DEBT, *lawyer* and *money* are selected by 41 and 63 per cent, respectively, of eight-year-olds. Only *doctor* was selected by 60 per cent of the eight-year-olds in relation to SICKNESS. *Wall* and *roof* were selected by 20 to 30 per cent of eight-year-olds, and then the percentage selecting them rose steadily and rapidly to 70 and 86 per

TABLE 4

Responses to "school"

AGE	BLACKBOARD	TEACHER	WINDOW	PEN	BELL	SCHOOL-HOUSE	PUPILS
8	63.0	68.0	11.0	7.0	12.0	15.0	24.0
9	51.0	76.5	16.5	4.5	5.5	10.0	36.0
10	44.0	64.5	25.5	0.5	6.5	20.0	39.0
11	34.5	68.0	27.0	2.0	1.5	30.5	36.5
12	26.5	60.0	29.5	0.5	2.5	36.0	45.0
13	22.0	57.0	35.0	1.0	2.0	32.5	50.5
14	21.0	59.0	28.0	0.0	0.5	38.5	53.0
15	16.5	64.5	22.5	0.0	2.0	36.0	58.5
16	20.5	61.5	26.0	0.0	1.5	35.5	55.0
17	10.5	74.5	16.5	0.0	1.5	29.5	67.5
18	11.0	76.0	15.0	1.0	1.0	23.0	73.0
19	4.0	82.0	12.0	0.0	0.0	28.0	74.0

TABLE 5

Responses to "building"

AGE	WINDOW	WOOD	CHIMNEY	WALL	SHINGLE	ROOF	STAIRS	SHED
8	60.0	20.0	52.0	20.0	8.0	28.0	6.0	6.0
9	60.0	19.5	52.0	21.5	8.0	30.5	5.5	3.0
10	51.0	20.0	45.5	30.5	6.5	42.5	3.0	1.0
11	53.5	11.5	38.0	41.5	4.5	48.5	2.0	0.5
12	40.5	16.0	23.0	54.0	6.0	59.0	0.5	1.0
13	43.5	24.0	15.5	53.5	3.0	59.5	0.0	1.0
14	39.5	17.0	17.5	56.0	4.5	64.5	0.5	0.5
15	31.5	16.0	18.5	59.0	3.0	72.0	0.0	0.0
16	32.5	17.0	10.0	63.0	2.5	73.5	1.0	0.5
17	20.5	16.0	7.5	72.5	3.0	74.5	0.0	0.0
18	20.0	18.0	5.0	72.0	4.0	81.0	0.0	0.0
19	20.0	20.0	4.0	70.0	0.0	86.0	0.0	0.0

cent respectively at nineteen. The essential elements of a DEBT, *debtor* and *creditor*, were selected by less than 20 per cent of eight-year-olds, but the percentage increased to 80 and 66 per cent respectively at age nineteen. This particular type of development is not shown so clearly with SICKNESS, where *doctor* is the only non-essential response selected by a large percentage of eight-year-olds. Of the correct responses, *weakness* was chosen by 48 per cent and *discomfort* by only 12 per cent of eight-year-olds. At nineteen years both of these were picked by about 80 per cent.

The last group of curves are those for GOVERNMENT and FRIENDSHIP, in both of which there is great overlapping, although it is more evident for the former. The responses to GOVERNMENT are shown in table 6. For eight-year-olds, *tax*, *king*, *navy*, *freedom*, and *capitol* were all selected by over 30 per cent of the children. *King*, *navy*, and *freedom* start a somewhat rapid and steady decline, while for twelve-year-olds *senate*, which started at 6 per cent, has increased to 36 per cent and reaches a maximum of 50 per cent for fifteen-year-olds. The correct responses, *capitol* and *tax*, steadily but slowly increase from the percentages of 42 and 30 at eight years to 74 and 62 at nineteen, but their development is at greatly different rates and they are always widely separated. This confusion is not so evident in FRIENDSHIP which more nearly resembles the responses to SICKNESS. Here the correct responses, *helpfulness* and *liking*, rise from percentages of 39 and 50 at eight years to 72 at nineteen, while *lover* starts at 45 per cent and decreases to less than 20.

TABLE 6

Responses to "government"

AGE	CAPITOL	CONSUL	NAVY	FREEDOM	KING	SENATE	CANNON	TAX
8	42.0	7.0	33.0	30.0	31.0	6.0	12.0	30.0
9	50.0	10.0	30.0	35.5	17.5	11.5	6.0	30.5
10	55.5	11.5	10.0	38.5	18.5	13.0	3.5	40.5
11	57.0	21.5	12.5	34.5	10.0	27.0	3.0	34.5
12	57.0	23.0	10.5	25.5	13.0	30.0	3.5	31.5
13	65.0	24.5	11.0	15.5	8.5	37.5	0.0	38.0
14	72.0	17.0	8.5	18.5	3.5	40.5	0.5	30.5
15	74.5	15.5	6.0	11.0	4.5	50.5	0.5	37.5
16	73.5	15.5	8.0	15.5	5.5	41.5	1.5	39.0
17	75.5	13.0	10.5	13.0	8.0	27.5	0.5	52.0
18	78.0	9.0	8.0	15.0	6.0	31.0	0.0	53.0
19	74.0	16.0	2.0	16.0	12.0	16.0	2.0	62.0

Discussion. The first six key words, CAT, TREE, SPELLING, SCHOOL, STORE, and BUILDING might be labeled concrete, and of these the third is an activity rather than a thing. Consistently throughout this group it seems evident that the younger children tend to choose related words which have a subjective reference. Disre-

garding the very simple series for CAT, we find that, of the incorrect words under TREE, *apples* is picked more frequently; under SPELLING, *writing;* under SCHOOL, *blackboard;* under STORE, *counter;* and under BUILDING, *window* and *chimney*. In each of these cases the correct word is one which has a direct relation to the child's activity in responding to that situation. He eats and enjoys apples from trees, at the same time he realizes that not all trees have apples; he writes his spelling lesson; in school his activity is directed toward the blackboard; at the store the counter is a focus of interest; and the child's building, usually on paper, emphasizes the presence of chimney and windows, or on the buildings he sees these are Gestalten set against a background of roof and wall.

Thus the younger children tend to feel that those things having a relation to them are essential to the concept. With increased age this basis of selection disappears. In all of these cases the differentiations between essential and non-essential relations have been made by twelve years of age. This self-reference is in striking harmony with the findings on play interests. Here the younger children are individualistic but with advancing age the reference tends to extend to other individuals—the self is extended to include companions.

The remaining key words, DEBT, SICKNESS, GOVERNMENT, and FRIENDSHIP, might be called abstract. In the responses to these we find a much greater variation. The younger children pick one or more unessential words and these words usually have a self-reference, e.g., *doctor* for SICKNESS. There is also evident in the younger children's responses the tendency to mark a word which may be more familiar, e.g., *money* as necessary to a DEBT, *navy* and *king* for GOVERNMENT. The final separation of essential and non-essential words occurs at varying but usually higher ages. Thus for DEBT it occurred at fourteen years, for GOVERNMENT not until sixteen, but for SICKNESS and FRIENDSHIP it took place at twelve years. There is also evidence that the development of vocabulary tends to assist in the final separation of the two types of responses. Thus *creditor* and *debtor* are selected by less than 20 per cent of eight-year-olds, and a 50 per cent selection is not reached until after fourteen years. In responding to GOVERNMENT, the curves for *senate* and *tax* interlace around 40 per cent from twelve to sixteen years.

It would appear that the development of logical relation of concepts passes through a stage of self-reference in children from eight to ten or eleven years of age. Furthermore the development of vocabulary is an important factor in the process of concept formation. Another point of interest is that, except for CAT and TREE, the essential elements were never selected by 100 per cent of the subjects even at the highest ages.

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Emotional Development in Early Infancy

Katharine M. Banham Bridges

THE emotional behavior of 62 infants in the Montreal Foundling and Baby Hospital was carefully observed and recorded daily over a period of three or four months. The circumstances attendant upon these reactions were noted, and the whole data was studied from the point of view of development from age to age. A summary of the findings will be presented in the following paragraphs. They will be seen to lend support to the writer's (2) (3) theory of the genesis of the emotions and to add further illuminating detail.

The babies under observation were in separate wards more or less according to age. In different rooms were infants under one month, one to three months, three to six months, six to nine months, nine to twelve months, and twelve to fifteen months. An older group of children between fifteen and twenty-four months of age played together in the nursery.

Table 1 shows the number of children at the different ages whose behavior was observed for this study.

Development in the emotional behavior of the young child comprises 3 main classes of change. From birth onward there is a gradual evolution of the emotions taking place. The earliest emotional reactions are very general and poorly organized responses to one or two general types of situation. As weeks and months go by the responses take on more definite form in relation to more specific situations. It seems to the writer, as already mentioned elsewhere, that in the course of genesis of the emotions there occurs a process of differentiation. Coincident with the partial isolation of certain responses is a combining of the simpler reactions within the unit responses and the formation of bonds of association between these emotional syndromes and detailed aspects of the provoking situations. In this manner slowly appear the well known emotions of anger, disgust, joy, love, and so forth. They are not present at birth in their mature form.

TABLE 1

AGE	NUMBER OF CHILDREN
months	
Under 1	3
1–3	10
3–6	23
6–9	18
9–12	11
12–15	20
15–18	8
18–21	5
21–24	6
Over 24	2

In addition to the progressive evolution of the emotions, there is, going on at the same time, a gradual change in the mode of response of each specific

emotion. Muscles are developing, new skills are being learned. So that the anger, for instance, expressed by the eighteen-month-old differs in detail of form from the anger manifested by the ten-month-old baby. Fresh bonds of association are being made between emotional behavior and the always slightly varying attendant circumstances. Different situations come to have emotional significance for the growing child and subsequently provoke emotional responses. Thus a gradual substitution takes place of the situations which prompt the emotions. In the language of the behaviorists, emotional responses become conditioned to fresh stimuli.

EXCITEMENT, THE ORIGINAL EMOTION

After observing the behavior of babies *under one month* of age, the writer felt more than ever convinced that the infant does not start life with 3 fully matured pattern reactions, such as have been mentioned by behaviorists and named fear, rage and love. Unfortunately the writer was not able to observe the infants within a few hours of birth, but this fact in no way invalidates observations made on children two or three weeks old. Moreover, if the above named emotional responses are really the 3 great primary emotions from which all our adult emotions are derived, surely they may still be observed a month or more after birth. And, even if the process of conditioning begins before or immediately upon birth, one may expect the original emotion-producing stimuli to elicit their natural responses at least for two or three weeks after birth.

It was observed in the hospital that, on presentation of certain strong stimuli the infants became agitated, their arm and hand muscles tensed, their breath quickened, and their legs made jerky kicking movements. Their eyes opened, the upper lid arched, and they gazed into the distance. The stimuli producing such agitation or excitement were: bright sun directly in the infant's eyes, sudden picking up and putting down on the bed, pulling the child's arm through his dress sleeve, holding the arms tight to the sides, rapping the baby's knuckles, pressing the bottle nipple into the child's mouth, and the noisy clatter of a small tin basin thrown on to a metal table whence it fell to the radiator and the floor.

The loud sound startled only four of the one- and two-month-old babies, while six others lay practically undisturbed. None of the infants cried after hearing the noise. The same experiment was tried upon children of successive ages up to fifteen months. Under two or three months the reaction was one of sudden but rather mild general excitement as described above. Children of three or four months and older gave more of a jump and looked definitely in the direction of the sound. Afterwards they remained still with eyes and mouth open, and stared towards the source of the commotion. One baby of eight months stiffened and turned away on the second trial. The corners of his mouth turned down, his eyes moistened and he looked to the adult for sympathy and comfort. Another child of eleven months sat wide-eyed and still, the corners of his mouth drooping as if he were ready to

burst into tears. The older children merely stood, or sat, alert and attentive without further sign of distress.

Lowering the babies suddenly into their cribs, and in some cases lifting them quickly, also startled and excited them. Sometimes they would cry following upon such a surprise. Rocking a quiet child would cause him to open his eyes attentively. But gently rocking a crying infant would often, though not always, cause him to reduce his activity, stop crying, and eventually become tranquil. Gentle handling, slow patting, wrapping in warm blankets, and nursing easily soothed an agitated or crying infant, making him relax and yawn and become sleepy.

Light pinching of the arm left the three- or four-week-old baby unmoved. Deeper pressure caused him to kick slightly, breathe faster and move his arms. A sharp flick on the hand produced similar agitation, but a second rap resulted in a sudden check to breathing followed by a prolonged cry and other signs of distress. The first exciting experience had been found disagreeable and the second rap produced unmistakable distress.

Time after time on waking suddenly from sleep the infants were observed to wave their arms jerkily, kick, open and close their eyes, flush slightly, and breathe quickly and irregularly. Some grunted, some cried spasmodically for a moment or two, while others cried loudly for several minutes. The combined stimulation of light, of sounds, of damp or restricting bed clothes, and the change from sleeping to waking breathing-rate seemed to produce a temporary agitation and often distress. Waking apparently requires emotional adjustment.

The hungry child before feeding would often show restless activity, waving, squirming, mouthing and crying at intervals. The infant who had been lying in one position for a long time and the tired child before falling asleep would also show emotional agitation. Their breath would come jerkily, uttering staccato cries of "cu-cu-cu-ah," and they would thrust out their arms and legs in irregular movements. At the moment the nipple was put into the hungry baby's mouth he again breathed quickly, occasionally cried, waved the free arm, and kicked in excited agitation.

The emotional reactions of the tiny infant are certainly not highly differentiated. The most common response to highly stimulating situations seems to be one of general agitation or excitement. It is a question which word most aptly describes the behavior. The former perhaps conveys more the idea of general disturbance, although the two words are often used synonymously. This vague emotional response to a large variety of circumstances must surely be one of the original emotions, if not the only one.

A kind of general excitement over new and startling or other highly stimulating circumstances may be seen at any age. The behavior manifestations vary from time to time, but the main characteristics of accelerated response, alertness, slight tension or restlessness remain as constant attributes. In the babies, excitement is frequently manifested in kicking movements. The month-old infants kick jerkily with both feet at random. In

another month or so, the kicking becomes more regular, the legs being thrust out alternately. By five or six months the babies express their emotions in combined leg thrusts, kicking with one foot, and in swinging the legs from the hips. At fourteen months when the children can stand they will hold on to a support and "mark time" with their feet or stamp. Stamping, jumping and running express excited agitation at a still later age.

Two- and three-month-old babies may be seen to suck their thumbs or fingers rapidly in moments of stress. At seven months and over, children bite, pull and suck their garments, as well as their fingers. This behavior seems to produce a gradual subsidence of the emotion. Body-rocking accompanied in many instances by rhythmic vocalizations is another expression of mixed emotion. Hungry, annoyed, excited or restless children will sit and rock for minutes on end. The five-month-old baby lies prone and pushes with his knees, or sways when lying dorsally. Seven-month-old infants support themselves on their arms and rock back and forth murmuring "m̄m̄-ŭm, m̄m̄-ŭm." After nine months they sit up and rock to and fro, or they kneel and bounce up and down holding on to the crib bars. Sometimes they sit and bump their backs against the side of the crib. This kind of behavior was observed in the nursery up to eighteen months of age.

Rhythmical movements were observed not only to be the outcome of emotional excitement or tension, but they were seen to have a soothing and pacifying effect. These must be attempts at adjustment on the part of the organism to reduce tension and restore emotional equilibrium or tranquility. In the light of these observations, it can be easily understood how long walks, games, field sports, singing, dancing, and sea-voyages are found to be so universally health-giving and positively curative for "nervous wrecks."

DISTRESS AND ITS DERIVATIVES

It is a moot question whether "distress" is an original emotion or whether it is a very early differentiated reaction to disagreeably painful and unsatisfying experiences. It may be that it is a part of the general emotional response of excitement which copes more satisfactorily with obnoxious stimuli. Tense muscles resist or remove pressure; activity warms a chilled body and reduces tension; and cries, at first reflex due to the rush of air in and out of the lungs, bring comfort and aid. These responses become differentiated from excitement, associated together and conditioned to the disagreeable stimuli as a result of experience. If such differentiation actually takes place, it must begin immediately after birth. For the two emotions of excitement and distress are already distinguishable in a three-weeks-old infant.

On the other hand, it is possible that there is a native emotional response to pain, particularly muscle pain. The sympathetic branch of the autonomic nervous system is predominantly active and the overt behavior is definitely that of distress. Other stimuli, such as loud sounds and sudden falling merely produce startled excitement. Blanton (1) observed that the infant's cry of colic had a specially shrill char-

acter accompanied by rigidity of the abdominal walls. She also noted that infants during the first days of life cried from "(1) hunger; (2) in response to noxious stimuli (including rough handling, circumcision, lancing and care of boils, sores, etc.); and (3) possibly fatigue or lack of exercise." The writer has observed the same phenomena in three-weeks-old babies. But, hunger, rough handling, and fatigue were also noticed on many occasions to produce a restless excitement rather than specific distress.

It is not easy, in the case of the very young infant, to distinguish distress from general agitation. Perhaps the most characteristic marks of the former are greater muscle tension, interference with movement and with breathing, closing of the eyes, and loud rather high-pitched crying. In children of two months and over, the eyes become moist and tears may flow. The crying of the infant *under a month* or even six weeks often seems to be part of the general activity in excitement. Breath comes more or less regularly, the cry emerging on both intake and expiration of air. There are no tears, and the skin does not flush. Movement is free though rather jerky; and the mouth is held open in an elliptic, round, or square shape.

The cry of distress, recognizable in the *month-old* baby, is irregular. There are short intakes of breath and long cries on expiration. The eyes are "screwed up" tight, the face flushed, the fists often clenched, the arms tense, and the legs still or kicking spasmodically. The mouth is open and square in shape or, more usually kidney-shaped with the corners pulled down. The pitch of the cry is high and somewhat discordant, and sounds something like "ah, cu-ah, cu-ah, cu-ǣh."

Cries of distress were heard from month-old babies in the hospital on the following occasions; on waking suddenly from sleep, struggling to breathe through nostrils blocked with mucous, when the ears were discharging, when lying awake before feeding time, after staying long in the same position, lying on a wet diaper, when the child's buttocks were chafed, and when the fingers were rapped. The three main causes of distress at this age, therefore, seemed to be discomfort, pain, and hunger.

Crying from discomfort and on awakening usually developed slowly, and sounded like "cu-cu-cu-cah-ah—." The cry of pain came suddenly, often after a holding of the breath. The sound was a loud shrill prolonged "ă-ă-ă," and lowered in pitch slightly from the first emission. The cries of hunger were rather like those of discomfort. The former came perhaps more in intermittent waves; the intervening moments being taken up with mouthing or sucking movements. Occasionally the hungry child would utter a sharp loud cry, as if in pain, and then whine or moan for a time.

Two-month-old babies cry less of the total waking time; but slighter discomforting stimuli seem to cause distress more frequently than in the case of the younger infants. They are more disturbed by a wet diaper, by flatulence, and by tight clothing which restricts movement and makes breathing difficult. Their movements are freer and they tend to move their heads from side to side when they

are distressed. While one-month-old babies kick irregularly with jerky movements, the two-month-old kicks his legs alternately and more regularly. He waves his arms up and down when agitated or distressed, as well as in spontaneous play. The sound or sight of an approaching person will not quiet his distress; but being picked up will do so, or being fed if he is hungry.

By *three months* of age a child will cry and show other signs of distress when placed in an unusual position or moved to a strange place; as, for instance, when lain temporarily at the foot of another child's bed. He will wave his arms laterally as well as up and down, and will kick more vigorously. The hospital baby has learned to associate feeding time with the presence of an adult; for, when he is hungry he shows some excitement at the close approach of a person. He stares at the person's face, waves, kicks, breathes faster, and opens his mouth. If no food is forthcoming, he becomes more tense and jerky in his movements and begins to cry. He is distressed at the delay in normal proceedings.

Should the adult remain tantalizingly near for some minutes without either picking up the child or feeding him, his cry increases in intensity, his eyes become moist with tears, he holds his breath longer, and utters prolonged flat "ă-ă-ă" sound reminiscent of an older child's "paddy" or temper cry. The infant's motor responses were all set for being picked up and fed, and then he was thwarted and disappointed. His excitement changed into bitter distress with a semblance of angry vexation.

The slight change in vowel sound of the cry, the long holding of breath combined with more than usually vigorous leg thrusts and arm movements, seemed to suggest that the emotion of anger is beginning to evolve from general distress at about this age. Although for the most part the distress shown at discomfort differs almost imperceptibly from distress in response to disappointment, occasionally the latter includes, to a marked degree, those behavior elements peculiar to the emotion of anger. The situations which evoke these demonstrations of temper in the tiny infant are a stop or check in the progressive satisfaction of a physical need. In the above instance the child's appetite was aroused but not satisfied. Lack of even the first sign of a need being satisfied merely produces vague distress.

A *four-month-old* baby shows distress at the same general sort of situation that troubles the younger child. He is, however, less frequently disturbed by bodily discomfort. He moves about sufficiently to relieve tired muscles and local pressures, and to eliminate gas from his stomach. He cries vigorously at delay in the feeding process and may show decided temper on such occasions. His arms then stiffen and tremble; he screws up his eyes, flushes, holds his breath and utters prolonged and irregular cries on expiration of breath; he kicks violently, pushes with his feet and looks at any adult, presumably to see the effect. He is getting very fond of attention at this age, and will show distress and often anger when a person leaves the room or ceases to pay attention and play with him.

At *five months*, the baby's interest in small objects, such as rattles, stuffed animals and, of course, his milk bottle, causes him to be distressed when these objects are removed. He may express his displeasure as formerly by crying, squirming, waving and kicking, but he may also be heard merely to call out in a protesting tone of voice, "ah aye," without the half-closing of the eyes and the accompanying tensions of crying.

By this age the child may show slight revulsion for certain foods, coughing, spluttering, frowning and crying while he is being fed. Chopped vegetables and soup too thick in consistency were specially disliked by some babies in the hospital. Cereals, milk, and sweetish foods were almost always taken readily. It was noted that babies under three months often refused to drink sterile water. They just let it run out of their mouths without swallowing. There was no emotion involved in this reaction. Similarly, three- and four-month-old babies sometimes rejected their thin vegetable soup, but were not very disturbed about it. A genuine emotional revulsion did not appear till five months or later. Perhaps this is the beginning of the emotion of disgust. Revulsion at nauseating sights and smells, the adult form of disgust, apparently does not develop until two or more years of age.

Several of the babies in the hospital *between six and eighteen months* were observed to splutter and choke, and refuse to swallow spinach more than other vegetables. The mouthfuls that were rejected were usually, though not always, those containing large or stringy pieces of spinach. When the latter was chopped fine it was swallowed a little more easily; but only when it was mixed with other vegetables was it eaten without any protest. There must be factors other than consistency and size of morsel to account for this objection to spinach.

It seemed to the writer that some cans of spinach tasted more bitter than others and were less palatable on that account. In order to find how the children would react to a bitter taste, two teaspoonsful each of unsweetened grape-fruit juice were given to nine children in the nursery. Four of them pursed or curled their lips, 1 turned his head away, and 1 frowned. The others sat still and solemn, and kept tasting their lips attentively for some time. There were certainly individually different reactions to this bitter-sour, astringent taste. Several of the children definitely disliked it and none of them seemed to like it. It is possible then that there is a bitter taste to spinach which may in part account for children's aversion to it. Another factor, that of the dark green colour of spinach may influence older children's and adult's feeling reaction towards it. One two-year-old in the hospital on turning away and refusing to eat the vegetable was seen to point to it and say "dirty."

The *six-month-old* baby's attention is usually arrested by the presence of a stranger. His movements are inhibited and he watches the newcomer intently. He is not pleased and one could hardly say he is afraid. But he seems diffident and uncertain what to do, or utterly unable to move for a few moments. At seven months he reacts

in the same way to the approach of a stranger, though the general inhibition of movement is greater and lasts longer. After a few moments or several seconds of tension he may begin to cry slowly, or burst suddenly into tears. The whole body is usually rigid and inactive. The eyes, previously wide open, close tight and the head bends. Should the stranger touch the child he will probably turn or draw away. Here is the emotion of fear already differentiated. Frightened distress results when the child through inhibition, ignorance, or inability finds himself unable to respond at all adequately to the situation.

At *seven months* of age an infant calls out protestingly when a familiar person ceases to attend to him, instead of crying distressfully like a four-month-old. He still cries and kicks angrily if some object in which he was deeply engrossed is taken from him. He does so also after being highly excited by a playful adult when the latter goes away or stops playing with him. He now makes prolonged attempts to get at objects out of reach. If he fails to attain his objective he may give up and cry in helpless distress, or he may just grunt in protestation.

A *nine-month-old* child will struggle longer and make more varied attempts to reach the object of his desire. Should he fail to do so after putting forth considerable effort he may become tense and red in the face with anger. He will kick and scream and look for assistance, while tears flow copiously. The cry at this age is becoming exceedingly loud, and tears flow more readily than at the earlier ages. Prolonged crying at four or five months is accompanied by slight lacrimal secretion, but after six months of age tears often flow down the child's cheeks as he cries, especially after an adult's attention has been attracted.

Strangers are still quite terrifying to the nine-month-old baby. His movements are more completely arrested by the unfamiliar presence than those of the six-month-old. He will remain immovable for several minutes unless the newcomer approaches very close to him. In that case he will lie face down or bend his head and probably begin to cry. At ten months of age he may even be so frightened as to flop down suddenly on the bed and scream loudly. Then follows prolonged and tearful crying.

When children of *ten months* and over are hungry, uncomfortable, tired, or fretful and unwell, they will set up a whine or cry as the result of suggestion when another child cries. They do not, however, ordinarily imitate crying when they are occupied and happy. Under these circumstances they may call or babble in a pitch similar to that of the other child's cry. Small objects which can be manipulated interest them so intensely that they can be distracted from a distressing trouble fairly easily at this age. These objects need not necessarily be new so long as they are freshly presented.

Year-old babies often cry suddenly when they feel themselves falling, or when they lose their grip while climbing. If they miss the assistance of a helping hand they will also sit down and cry loudly. Sometimes their emotion is anger at the thwarting or failure of their endeavors. They scream, flush, and tremble in rage. At other

times they sit motionless in fright and look for aid or comforting sympathy. When strangers approach the *twelve- or thirteen-month-old* baby he may hold his hand behind his ear in a withdrawing motion and stare apprehensively. He may actually hide his eyes behind his hands or look away so as not to see the awe-inspiring or annoying intruder.

At *fourteen months* or thereabouts we may see the real temper tantrum. At least, that is the age when it became noticeable in the hospital. If a child is not given his food or a coveted toy exactly when he wants it he may respond by throwing himself suddenly on the bed or floor. He then screams, holds his breath, trembles, turns red, kicks or thrusts his feet out together. Tears flow and he will wave away anything that is not the desired object. These outbursts may occur frequently for a few weeks, or only spasmodically for another year or eighteen months. The children under observation seemed to have their "off-days" when they were fretful and easily distressed or roused to anger. Such days were usually when they were incubating or recovering from colds, when the hospital routine was disturbed, or after the children had been excited by parents' visits.

Distressful crying becomes less common as the months go by. Extreme hunger and weariness after a long day or great activity may be accompanied by whining and intermittent outbursts of tears. Anger is expressed more in protesting shouts, pushing and kicking, but less in tearful screaming. So long as adults are present, however, the interference and rough handling of another child may bring forth cries and tears. A *fifteen-month-old* may show his annoyance by hitting a child who has taken his toy or who is holding on to the thing he most wants. He may even bite him or pull his hair without a preliminary scream or shout.

The attention of familiar and interested adults is much sought by children of *fifteen to eighteen months.* If such attention is given to another child there may be signs of deep distress. The neglected one may stiffen, stand motionless, bend his head and burst into tears. Here is perhaps the beginning of jealousy, distress at the loss of, or failure to receive, expected attention and affection. Some children will show aggressive annoyance when another receives the attention they covet. They do this usually by hitting the envied child.

A *twenty-one-month-old* child will show less mistrust of strangers than will a younger infant. He may, however, run away and watch the newcomer for a time at a safe distance. After eighteen months he shows anger at adult interference by obstinate refusal to comply with their requests. He may shake his head and refuse either to be fed or to feed himself. At two he will play with his food, throwing it about instead of eating it, as a spite against some offending or scolding adult. Distress is shown chiefly at pain and acute discomfort, though the child will cry miserably at much less discomfort if a sympathetic adult is close at hand.

The children in the nursery group, *between fifteen and twenty-four months,* were more or less unconcerned when being undressed for the annual physical

examination. This part of the procedure was familiar and not unpleasant. Several of the children cried and stiffened somewhat when placed on the table in the examining room. One or two continued to show distress throughout the examination. Others smiled cheerily at the attendant nurse or the doctor, until they felt sudden and unexpected local pressure. All of the children cried at some time during the procedure. The most distressing events were when a flashlight was thrown into the eyes, and when the throat and ears were examined with the aid of the usual tongue-depressor and otoscope. The children had to be held firmly and their movements curbed during these operations.

It was patent to the observer that the children were undergoing rather different emotions according to their fast-developing individual idiosyncracies. Some were mainly startled and afraid, their movements were paralyzed. Some seemed to be just generally distressed at the unusual proceeding and the discomfort; while others were chiefly annoyed at the interference with their freedom. Several children showed signs of all three emotions. These individual differences probably have their foundation in variants in the physical constitutions of the children, both hereditary and acquired. They are certainly very much determined by the particular experiences the infants have gone through since their birth. A continuous study of behavior week by week reveals the actual differentiation and consolidation of individual traits of temperament.

Two or three of the nursery children over fourteen months developed fears for specific objects or persons. Toy animals that squeaked frightened one or two, causing them to draw away, stare wide-eyed and perhaps cry. This squeak could hardly be called a "loud low sound" such as Watson (4) describes as one of the original fear-producing stimuli. The sound is, however, rather unusual and comes at first as a surprise to the babies. One child was afraid of a particular aggressive little boy. No doubt he had gone up and hit her unexpectedly some time when the nurses were not watching. One youngster showed fear of a dark grey dog with a rough fur, rather different from the soft teddy-bears and other stuffed animals in the nursery.

Parents often remark how their children may suddenly show fear of some surprisingly trivial and inoffensive object. The answer to this may be found in certain partial associations with disturbing events of the past. It may also be found in the particular mental set of the child's mind and body when he came in contact with the object. He may have become suddenly aware of its presence and perceived it as an unwelcome intruder upon an entirely different line of thought or action. Still another phenomenon may account for the peculiar fears and objections of children. Timid behavior may be actually learned and preserved as a social asset, one of the numerous means of drawing attention.

The nursery child who cried and crawled away after touching the rough-haired, stuffed animal was flattered with the attention of all the adults in the room. A nurse brought the dog

up to the child, smiling and saying "nice doggie." He looked up at her face, saw her kindly smile, then bent his head and began to whimper again. Another nurse laughed appreciatively as he put his hand to his eye, and tried to coax him with a toy cat. He turned away quickly, cried out again, then looked up to see the effect on the adults. He was having a delightful time out of his apparent fear.

DELIGHT AND ITS DERIVATIVES

Delight is much later in becoming differentiated from general excitement than distress. The baby under a month old is either excited or quiescent. Gentle stroking, swaying and patting soothe him and make him sleepy. When satisfied after a meal he is no longer excited nor even distressed by hunger. And yet he is not positively delighted. He is just unemotionally content, and either tranquil or busy mouthing and staring at distant objects. When he is *over two weeks old* he will sometimes give a faint reflex smile upon light tapping at the corners of his mouth. This is hardly an emotional response.

One- and two-month-old babies cry and kick from hunger before they are fed, rather than show delight on presentation of the much desired food. They become calm, however, immediately when given their milk, but not at the mere approach of the adult who brings it. At two months infants will give fleeting smiles upon being nursed, patted, wrapped warmly, spoken to, tickled, or gently rocked. Perhaps this is the beginning of the emotion of delight.

By *three months* of age the emotion of delight is becoming more clearly differentiated from agitated excitement on the one hand and non-emotional quiescence or passivity on the other. The child kicks, opens his mouth, breathes faster, and tries to raise his head upon sight of his bottle. He gives little crooning sounds when being fed, nursed or rocked. He smiles when an adult comes near and talks to him; and he will even stop crying momentarily at the sound of a person's voice. He may also show delight in distant moving objects. One baby in the hospital, for instance, lay and watched the moving leaves of the creeper on the window for a minute or two at a time. Her eyes were wide and her mouth rounded and open. At times she would breathe fast, or inspire deeply, and utter murmurings of "uh-uh-uh." Her arms would wave up and down and her legs kick alternately.

The chief characteristics of delight are: free as against restrained movement; open eyes and expansion of the face in a smile as contrasted with the puckering of the forehead and closing of the eyes in distress; body movements or muscle tension of incipient approach rather than withdrawal; audible inspirations and quickened breathing; soft, lower pitched vocalizations than those of distress or excitement; more or less rhythmic arm and leg movements; prolonged attention to the object of interest; and cessation of crying. Although behavior varies in detail from child to child at successive ages, delight is always recognizable from certain general types of response. Free and rhythmic movements, welcoming and approaching gestures, smiles and vocalizations of middle pitch are most common features.

A *four-month-old* baby laughs aloud

when some person smiles and frolics with him. He smiles in response to another's smile and even when anyone approaches his crib, whether they be strangers or not. He spreads out his arms, lifts his chin, and tries to raise his body in approach to the attentive person. He takes active delight in his bath, kicking and splashing the water. Food, though sometimes welcomed eagerly, is often neglected for the more interesting attendant who talks and smiles at him.

At *five months* a child vocalizes his delight in sounds of "uh-uh-ung" in addition to waving, laughing, kicking and wriggling around. He shows special interest in small objects that he can handle and explore. Musical or noisy rattles are popular at this age. When hungry he kicks, breathes fast, and calls out eagerly at the first sign of the person who brings his food. His smiles are more transient, however, and his movements less vigorous on approach of a stranger.

By *six months* of age a child will reach towards a familiar person but will lie still and observe a stranger dubiously. He crows and coos frequently, taking pleasure in his own movements and sounds. In the hospital the babies of this age would watch each other through the bars of their cribs, sometimes laughing and kicking in response to the sight of the other's movements. They would swing their legs rhythmically when lying on their backs, or sway sideways when lying prone.

A *seventh-month-old* baby is becoming increasingly interested in small objects and in the act of reaching and grasping those close at hand. He will even struggle to attain things somewhat out of his reach. When his efforts meet with success he often smiles, takes a deep breath and expresses his satisfaction in a sort of grunt. After a moment or two spent in examination and manipulation of the object, he goes exploring again with fresh vigor. Possibly this is the beginning of the emotion of elation, exhilarating pleasure in personal accomplishments. Resting periods, after the delightful satisfaction of feeding or explorative activity, are often taken up with a rhythmical rocking back and forth, the child supporting himself on his hands and knees.

At *eight months* of age the child seems to take more delight than ever in self-initiated purposeful activity. He babbles and splutters and laughs to himself. Especially does he seem delighted with the noise he makes by banging spoons or other playthings on the table. Throwing things out of his crib is another favorite pastime. He waves, pats, and coos, drawing in long breaths, when familiar adults swing him or talk to him. He will watch the person who nurses him attentively, exploring her, patting gently, and often smiling. Here are perhaps the earliest demonstrations of affection. The child will also pat and smile at his own mirror image. But his behavior is rather more aggressive and inquisitive than really affectionate.

A *nine-month-old* baby is very popular with adults. He laughs frequently, bounces up and down and tries to mimic their playful actions. He pats others babies exploratively but does not show particular affection for them. Strange adults may frighten him at

first. But, after studying them for some time in the distance, he will smile responsively and join in play with them. By *ten months* of age the child is taking more interest in other babies. He will mimic their calls and even their laughter. The hospital babies of this age would pat and bang and laugh in imitation of each other.

An *eleven-month-old* baby takes great delight in laughter, not only his own but that of another. He will laugh in order to make another child laugh, then jump and vocalize and laugh again in response. At twelve months of age he will repeat any little action that causes laughter. He is becoming increasingly affectionate. He puts his arms around the familiar adult's neck, and strokes and pats her face. Sometimes he will actually bring his lips close to her face in an incipient kissing movement. He looks eagerly for attention; and may stand holding a support and changing weight from one foot to the other in rhythmic motion, as a solace when neglected.

Between *twelve and fifteen months* a child usually learns to walk with a little help. This performance, though often accompanied by panting and tense effort, causes great delight and even elation when a few steps have been accomplished. The child calls out, smiles and waves ecstatically (i.e. rapidly or jerkily). Without further encouragement from adults, he will then set out again with renewed fervor. When attentive adults are too enthusiastic in their appreciation, the little one may become positively tense with excitement. His efforts may consequently meet with less success, and then he cries in vexatious disappointment.

There is already a noticeable difference between the responsiveness of different *fifteen-month-old* children to demonstrated affection. Some children come readily to be nursed and petted, others require a little coaxing. One or two will kiss back when kissed, while others merely cling closely to the adult caressing them. At this age the children begin to show definite affection for each other. They take hands, sit close to one another, put their arms about one another's neck or shoulders, pat and smile at each other. Eighteen-month-olds will also jabber nonsense amicably together. Again, with regard to playmates as well as adults some children are more affectionate than others.

These variations in affection no doubt have a number of causal factors. They depend upon the child's physical constitution and his condition of health at the moment. Sick children may be very clinging and affectionate with adults, or, in some instances, refractory and irritable. They may be both by turns. Whether a child is affectionate or not also depends upon the nature of his dominant interest at the moment. Affection for a grown person depends upon the child's attitude towards adults in general; and that again is largely a matter of the amount of fondling or scolding the child has received. Affection for other children is considerably determined by the agreeable or exasperating nature of chance contacts.

Between *fifteen and twenty-one months* the children find increasing enjoyment in walking and running about. They chase each other laughingly and enjoy snatching one another's toys. They come back again

and again to adults to be lifted high or swung round. The nursery slide is very popular at this age. One or two of the hospital children pulled away and watched apprehensively in the distance after the first slide. A little encouragement from the nurses and the eager shouts of the other children soon overcame their fear, and they joined the sliding group again.

Gramophone music was listened to intently by almost all the nursery children. Some of them responded by swaying or nodding motions to time. The children at this age were beginning to find individual interests in things and to express their enjoyment each in their own peculiar way. Absorbed preoccupation, tight clasping, biting, and varied manipulation of the attractive object were common expressions of interest. Some children would knock one object against another in play, some would collect things, and others would find pleasure in throwing and scattering toys about. These variations in appreciative interest in things and activities may be the precursors of the more mature emotion of joy.

Most of the eighteen-month-olds in the hospital were anxious to attract attention. They called out or came running to greet an adult. They would smile and hold out their arms to a familiar nurse in expectation of being lifted. A stranger they would watch solemnly for a while. Then they would approach slowly, touch and explore her clothes, or hit and watch for the effect. The children seemed to recognize their nurses at this age, whether the latter appeared in uniform or not. Babies of seven to twelve months, however, would sometimes turn away in fear or hostility when the nurses approached them wearing outdoor clothes.

Slight preferences for certain nurses were noticed as early as six months, but definitely affectionate attachments were observed chiefly between the ages of twelve and twenty-four months. One or two youngsters of eighteen months showed preferences for certain playmates. A twin boy and girl seemed especially fond of each other. The children would be more responsive and playful with those they liked, more delighted at their approach and very anxious to keep them close. Some children were friendly with almost everybody including strange visitors. Others showed more specific and decided likes and dislikes. When a terrifying stranger was present, some times a child would show more than usual affection for his familiar nurse, but at other times he would be restrained and aloof from everybody. Similarly when a beloved parent was nursing a child on visiting day he might be hostile to anyone else; but more often he would smile agreeably at everybody including awe-inspiring strangers.

A specific "like" does not necessarily enhance a specific "dislike" by force of contrast, though this does sometimes happen. If the disliked object threatens the satisfaction or enjoyment of the object preferred then the dislike becomes stronger. Similarly a preferred object may be enjoyed with greater intensity in the presence of, or following upon, something disliked. It is a comforting relief from distress. This effect of contrast is perhaps what

Freud terms "ambivalence." There are situations, however, where it has no noticeable effect. For instance, as cited above, a child made happy by one person may like everybody for the moment, regardless of previous attitudes towards them. A troubled child may be annoyed with everybody, even his favorite playmates. Strong emotions may thus have a decided "halo" effect.

Although children between *eighteen months and two years* of age tease and hit each other frequently, they show more affection for one another than younger infants. They not only pat and stroke fondly, but they will kiss and hug each other on occasion. The older children in the nursery group were seen to direct the younger ones' activities and point out their errors by gesture and exclamation. There was no evidence, however, of the parental affection and almost self-sacrificing care shown by four-year-olds for their much younger playmates.

Noisy activities delighted the eighteen- to twenty-four-month old youngsters. They took pleasure in tearing and pulling things to pieces and in lifting large but portable objects, such as their own chairs. They jabbered happily to each other at table. One child would repeatedly make strange noises to arouse the attention and laughter of another. With adults they would practice newly learned words and would seek to share their enjoyments. When the children received new toys in the hospital they would cling to them and guard them jealously from the other children. But they would hold them out for the nurses to share in their appreciation. Here is a mark of trusting friendship for their kindly guardians such as the children had not yet developed for one another. They would always rather share the other child's plaything than give up or share their own.

Affection, thus, begins as delight in being fondled and comforted by an elder. It becomes differentiated from general delight and manifested in tender caressing responses at about eight months of age. This earliest affection is essentially reciprocal in nature. Spontaneous affection for adults may be seen, however, by eleven or twelve months of age. Both reciprocal and spontaneous affection for other children make their appearance around fifteen months, but they are not as strong as affection for adults.

Specific affection for the grown-ups who give special attention may be manifested as early as demonstrative affection itself, i.e. eight or nine months. These preferences persist as long as the care and attention continue. Attachments between two children were not observed in the hospital till after fifteen months of age. They were usually very temporary, lasting only for a few hours or days. The behavior of a child-friend is so much more erratic and less dependable than that of an adult. Friendships between eighteen- to twenty-four-month-old children would sometimes last, however, for several weeks. There seemed to be no preference in these attachments either for the same or the opposite sex. Little girls would become friends together, or little boys, or a boy and girl would show mutual affection for one another.

SUMMARY AND CONCLUSION

The emotional behavior of young infants as observed in the Montreal Foundling and Baby Hospital seemed to lend support to the writer's theory of the genesis of the emotions. Emotional development was found to take place in three ways. The different emotions gradually evolved from the vague and undifferentiated emotion of excitement. The form of behavior response in each specific emotion changed slowly with developing skills and habits. Different particular situations would arouse emotional response at succeeding age-levels, although these situations would always be of the same general type for the same emotions.

The one-month-old baby showed excitement in accelerated movement and breathing, upon any excessive stimulation. He exhibited distress by crying, reddening of the face and tense jerky movements at painful and other disagreeable stimulations. But he was more or less passive and quiescent when agreeably stimulated.

By three months of age the child was seen to exhibit delight in smiles, deep inspirations and somewhat rhythmic movements when his bodily needs were being satisfied. Between three and four months angry screaming and vigorous leg-thrusts, in response to delay in anticipated feeding, were observed. A few weeks later anger was aroused when an adult's playful attention was withdrawn.

Distress and delight came to be expressed more in specific vocalizations with increasing age. General body movements gave place to precise responses to details of a situation. A four-month-old baby would laugh aloud with delight and cry tearfully when distressed. A child of five months was seen to cough and reject foods of a certain taste and consistency in incipient disgust. He would reach towards objects that caused him delight. By six months of age he showed definite fear when a stranger approached. He remained motionless and rigid, his eyes wide and staring. It is possible that "non-institutional" children might show fear in response to other unusual or unexpected events a little earlier than this. There was little variation in the daily routine of the children under observation, and fear was a rare occurrence.

By seven months of age the child showed positive elation, and renewed his activity as a result of success in his own endeavours. At eight months he began to show reciprocal affection for adults, and by twelve months spontaneous affection. Delight was manifested in much laughter, bouncing up and down, and banging with the hand.

Between nine and twelve months of age the hospital babies would hide their heads, like ostriches, upon the approach of a relatively unfamiliar person. They would scream and become flushed with anger when their efforts or desires were thwarted; and they would cry out in fear and sit motionless after perceiving themselves falling.

It was observed that a child learns to kiss soon after twelve months of age, and by fifteen months he expresses his affection for other children. Anger over disappointment becomes more dramatic in its manifestation. The true temper-tantrum makes its

appearance roughly about fourteen months of age. By eighteen months anger at adults is expressed in obstinate behavior; and annoyance at interfering children is manifested in hitting, pulling and squealing.

Eighteen-month-olds would constantly seek the attention of adults, and take great delight in running about and making noises. One or two children of this age showed depressed, and others angry, jealousy when another child received the coveted attention. A few specific fears were noticed; and several children developed particular affectionate attachments.

Thus it seems that in the course of development, emotional behavior becomes more and more specific, both as regards arousing stimuli and form of response. Distress, though more readily aroused, comes to find adequate expression in a variety of actions, and delight becomes sensitive appreciation and joy in numerous pursuits. The emotions, evolve slowly, and the exact age of differentiation is difficult to determine.

A diagram showing the approximate ages of the appearance of the different emotions, as observed in the Montreal Foundling Hospital, is given in figure 1. Study of a number of children in private homes might suggest a somewhat different age arrangement. Readers of the Journal of Genetic Psychology will note that a greater number of different emotions are attributed to the two year level than were suggested in a previously published diagram, (3) based on a study of nursery school children.

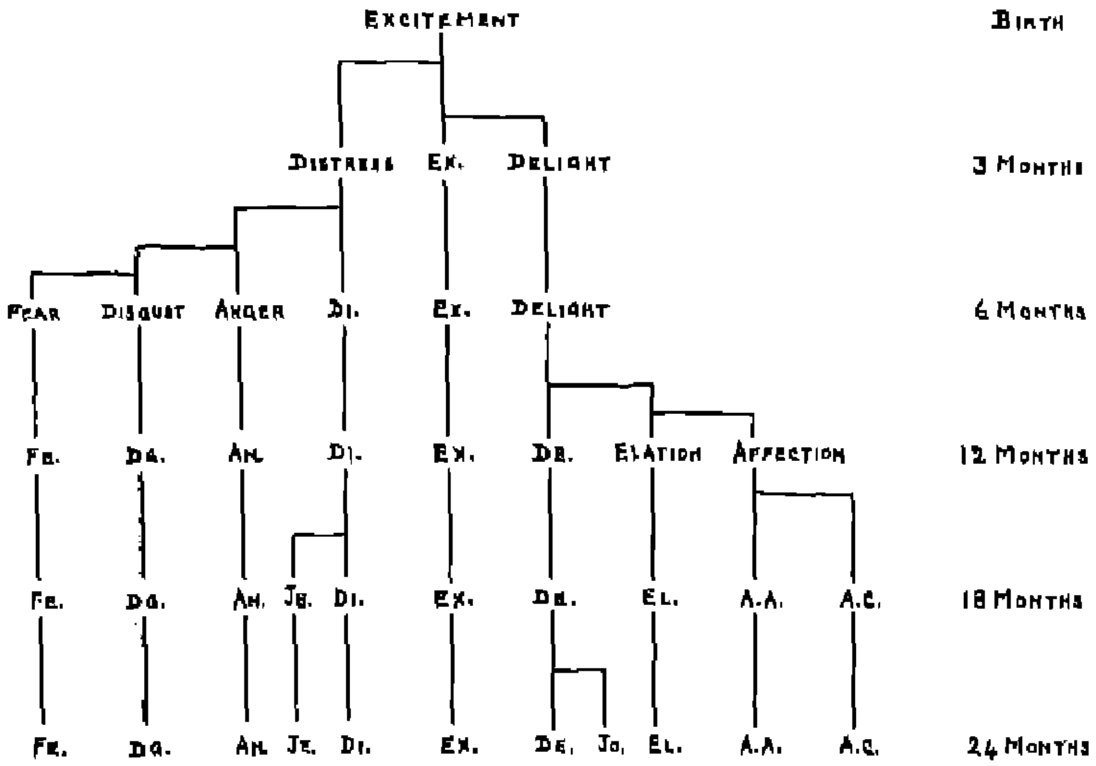

FIG. 1. SHOWING THE APPROXIMATE AGES OF DIFFERENTIATION OF THE VARIOUS EMOTIONS DURING THE FIRST TWO YEARS OF LIFE

Key: A.A. = Affection for adults, A.C. = Affection for children, An. = Anger, De. = Delight, Dg. = Disgust, Di. = Distress, El. = Elation, Ex. = Excitement, Fe. = Fear, Je. = Jealousy, Jo. = Joy.

Emotional behavior and development are very much determined by particular events and experiences and the routine of living. It is, therefore, to be expected that "institution babies" will show some deviations in their reactions from those of children at home. The former will probably exhibit fear of a larger number of things than other children, due to their very limited experience. On the other hand, they may show greater tolerance of interference, as a result of much practice in self-control in the nursery. They may also be more affectionate with other children, in consequence of the many happy play-hours spent together.

The daily round of feeding, washing, dressing and sleeping, however, has so many factors in common for all babies, that the observations made on the emotional development of a few hospital children, and the suggested inferences presented above, may have at least some general significance for infants brought up under other circumstances.

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which are "very good for grown people," but he also recalls and reflects upon other instances which comprise certain behavior responses acceptable on the part of adults but not for children. Among such instances called to mind by Trott are such situations as the repetition of slang which is evidently quite proper for adult use, the difference in the amount of conversation permissible, the matter of tearing clothes, and behavior in church, all of which seem to indicate the existence of different standards for adult and child behavior. These instances, requiring no small amount of insight and judgment, comprise, in part, Trott's thinking while the ladies are chatting, and he concludes that these differences in conduct standards must be accepted as "something established, inevitable, a law one must bow to." (1—p. 12)

Later when Trott is approximately eight years of age he "pities his little sister and admires her patience" when visiting ladies insist upon inserting their fingers into little sister's mouth and feeling the new tooth. "It must be exceedingly aggravating." Then, however, Trott generalizes quite remarkably, "Well, to each age its trials." After the little sister's refusal to accept the new diet, Trott is not only nonplused, but "he has a foreboding that tomorrow it may be the same thing, and the next day also" concluding with the rather whimsical generalization that "life is a very complicated affair." In the chapter from which the last excerpts were taken, Chapter 20, approximately 13 per cent of the total number of behavior items are related to such generalization processes.

Another departure from child psychology is exemplified in the child's resistance to a tremendous amount of social pressure. The author attributes to Trott at the age of four or five not only unusual preceptual and ideational abilities when he gives the child the ability to comprehend the social chatter and gossip of adults and to reflect upon it, but he also enables Trott to react to the injustice of snobbish criticism, class distinction, and social ostracism of a former member of the particular social clique represented by his mother and the other ladies at the tea.

Assumptions of a questionable nature also are those assigning powers to Trott which enable him to judge from adult standards certain acts and verbal expressions as being ugly and characteristic of ill-bred children. Moreover, he is given the ability to detect from facial expressions and mannerisms with unerring accuracy such attitudes and reactions as lack of understanding, assent (from the eyes), wistfulness, and worry.

The author also causes Trott to react inconsistently in his conversations with "the poor little boy." He presents a curious mixture of precocious, critical judgments as to the truth of the poor boy's statements and the ordinary questioning processes so characteristic of children of Trott's age. Rapid, unusual rationalization processes occur in a few seconds of stress when Trott discovers that God has left no roll in the hole under the rock where the boys had prayed that it should be left. (God was too busy, or he had forgotten, or the rolls burned, and it would have been better to have left one even though it were burned.)

A few statements as to the little sister's development should be included. Lucette "had been in existence only three days when she could distinguish perfectly night and day, light and dark." It is probable that the infant was sensitive to varying amounts of light and dark, but that is all. Soon Lucette "began to be naughty on purpose." While Trott was attempting to amuse his little sister during the introduction of the new diet, Mlle. Lucette "regards him coldly with a look of disdain which unmistakably says 'Contort yourself as you please, I am not your dupe.'" After the removal of the refused food, "Clearly, defiance, complete defiance possesses her." Such statements as these imply on the part of an eight month old infant an understanding of social behavior, motives, and attitudes which is unwarranted. The necessary perceptual and ideational abilities are not sufficiently developed at this early age to permit such comprehensive understanding.

These examples taken from the results of a detailed analysis indicate the limitations in the use of this type of fiction that must be recognized by teachers and students.

Similar examples could be taken from other works but the results of the foregoing analysis are sufficient to illustrate our point. Before any novel is recommended as a source of principles of child psychology it should be carefully analyzed to determine to what extent the characters are real children and to what extent the author uses them for his convenience to create the story or to express a generalization which may hold true in adult life, but which does not necessarily take cognizance of child development.

In conclusion, the writers wish to remind the reader that they are not challenging the value of this nor of any other piece of fiction. *Trott and His Little Sister* is indeed a charming story and exceedingly interesting. As a story and a creative piece of art it ranks high. To recommend it without qualifications for use as child psychology material is superimposing a function for which the book was never intended. When it is viewed from the point of view of this unusual function it is, therefore, not surprising that there are limitations. But these limitations do not apply when the narrative is considered in the light of the major purpose of fiction—to present a creation of the author.

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Clinical Identification of the Prospective Non-reader

LORENE TEEGARDEN

THE tendency to reverse and confuse symbols in reading is believed to be one of the prime causes of failure to learn to read, in a child whose intelligence and vision are normal. Confusion of symbols through failure to distinguish their exact position and sequence makes reading difficult; difficulty without adequate appreciation and help in overcoming the trouble produces failure; and failure produces dislike and antagonism. The result is the non-reader, the child who after several years of the usual school instruction has not learned to read though he seems normal in alertness, interest, and activity in other things.

"But why identify the non-reader clinically?" some may ask. "He identifies himself. You can not miss him when you have him in a class. What we need is methods for teaching him to read."

Yes, but even more we need methods for identifying him before he becomes a failure, and for giving him the special help that will save him from the searing experience of failure, and enable him to learn to read at the proper time.

This report presents a study conducted for the purpose of identifying in the first few months of school the child who is in danger of becoming a non-reader because of a strong tendency to reverse and confuse symbols in reading.

PLAN OF THE STUDY

1. Tests were devised to measure the tendency to reversal in children just entering first grade.

2. From the results of these tests 50 children were selected for individual study, ranging from those who had exhibited a strong tendency to reversal, through all levels to those who revealed no such tendency.

3. The individuals selected were studied clinically by means of standardized psychological tests, and special tests devised to examine types of reactions which it was thought might be related to the reversal tendency.

4. At the end of the year standardized primary reading tests were given in order to (1) measure the actual progress in reading; (2) correlate reading achievement with scores on the reversal tests given the previous September; and (3) to compare reading progress with the various types of clinical pictures revealed in the individual studies.

Reversal tests

Full details of the group tests for the tendency to reversal are not re-

ported here. A review is given of the general plan of the tests and the results. The battery included 4 tests, only two of which were used in computing the reversal score.

1. Writing letters or digits from memory. This was intended to reveal something of the child's previous experience and familiarity with symbols. Because of the varying factor of experience it was not included in the reversal score, but it gave valuable clinical information about the child.

2. Matching script letters and digits. Fifteen of the most confusing characters were mimeographed in duplicate on a sheet of paper, arranged in different order in two vertical columns. The children were told to find those that were exactly alike and to tie them together by drawing a line between them. This test was not scored, but was used as a preliminary practice test, to insure accurate and dependable results from a similar test of matching printed letters and digits.

3. Matching printed characters. Similar in plan and procedure to test 2. Given after test 2, the instructions were better understood, and we could be sure that each child was trying to do the thing that was required of him. This test was scored.

4. Copying of nonsense characters. In order to avoid the complication of experience, ordinary letters and digits could not be used. Nonsense symbols were devised, presenting many combinations of loops, lines, and curves, varying in difficulty from a single loop and line to some that were difficult enough to tax the ability of the best six-year-old.

Scoring of the tests was based on the plan of plus credit for correct work and minus credit for incorrect matching and reversals in copying. Each child, then, made a positive and a net score. The former was the total of correct work, the latter was what remained after subtraction of the minus credit for errors. The sum of positive and net scores for both tests was called the sum score, and was used as the measure of achievement level in the reversal tests. A quotient score, computed by dividing the net score by the positive score, was used as a measure of accuracy in the work attempted. For a performance free from errors, the quotient score was 100, while the sum score, determined by the amount of work attempted, might be high or low.

The reversal tests were given in September during the second and third weeks of school to 258 children just entering first grade, including 135 with kindergarten training and 123 without. Children repeating first grade work were eliminated in order to make more constant the factor of experience.

Scores on the tests were arranged in order from best to poorest and 50 children were selected who were scattered throughout the range. Thus we attempted to secure for comparative clinical study children with all degrees of the tendency to reversal and confusion of symbols. These children were examined between late October and the middle of December of their first semester in school.

The clinical examination

The Stanford revision of the Binet scale was used in complete form, with

one addition in procedure. For the counting of 13 pennies record was made of the hand used by the child, and the direction in which he moved in counting.

sought. For this a simple gravity toy was used, called "Bizzy Andy, Jr.," and manufactured by the Wolverine Manufacturing and Supply Company, Pittsburgh. It is obtainable in

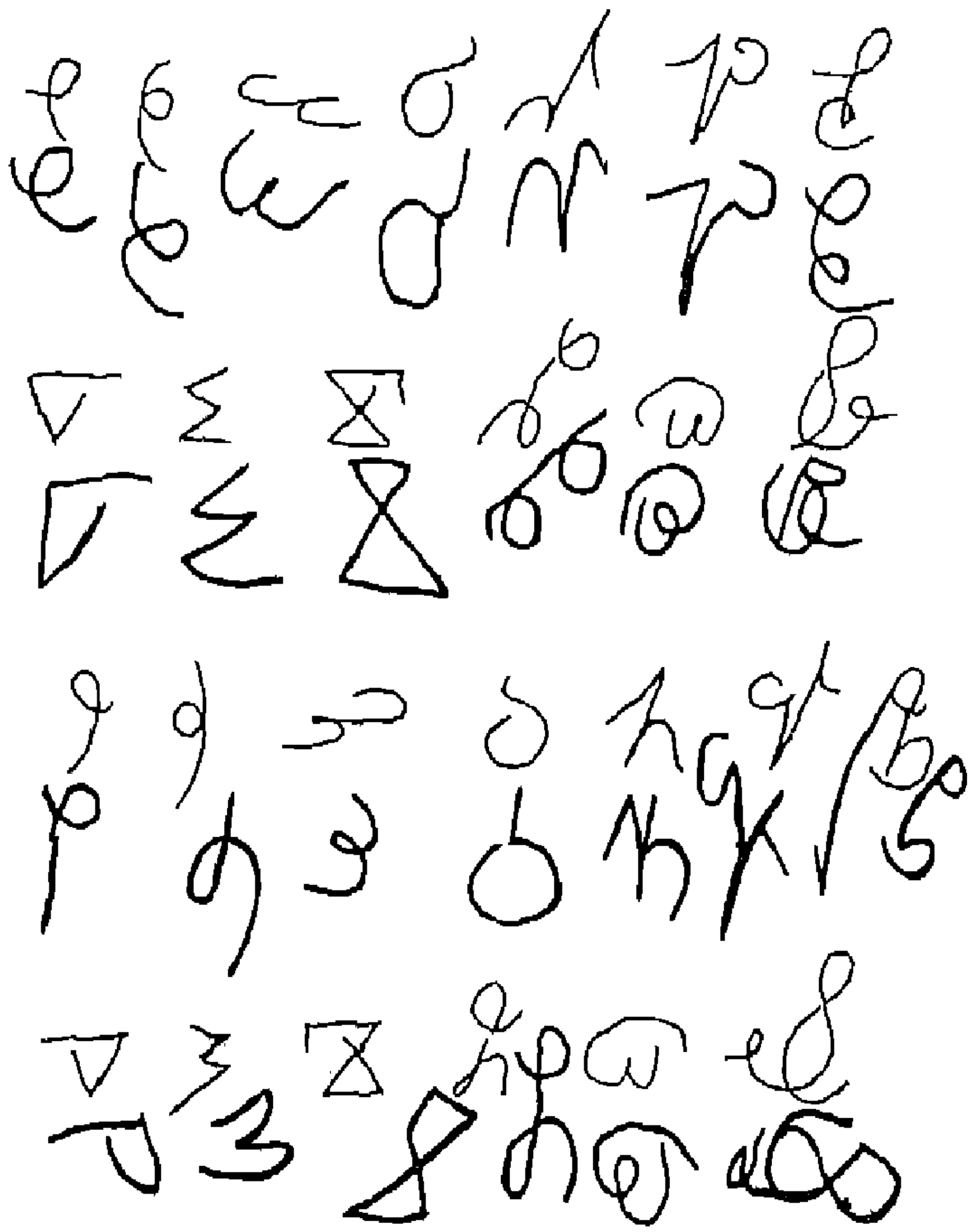

FIG. 1. ILLUSTRATION OF NONSENSE CHARACTERS AND A CHILD'S COPY OF THEM

The Seguin-Goddard formboard was the only standardized performance test used. Careful record was kept of the hand used, and the accuracy as well as speed of each performance.

A more exacting test of manual dexterity than the formboard was almost any ten cent store. The toy consists of an oblong metal pan into which is fitted in a slot at one end an upright which holds at the top a sloping metal chute long enough to hold a row of eight marbles which are kept from rolling out at the lower end

by a protruding piece of metal on either side. The lower end of the chute is directly over the middle of the pan. The upright is pierced by a slot in which a lever is swung on a bar. The short end of the lever is weighted with metal so that it is down when the toy is idle. The other end comes up to meet the lower end of the chute, and a tongue on the end of the lever protrudes through a notch in the chute so as to lift the first marble and cause it to roll over the metal obstruction which held it, into the end of the lever, which is hollowed to receive it. With the weight of the marble this long end of the lever drops, and the marble rolls into the pan below, whereupon the lever flies up to receive the next marble, which has rolled down to the end of the chute. Thus the swinging lever continues to drop marble after marble until the chute is empty.

Two containers filled with marbles were placed, one on either side of the toy and equally distant from it. The child was told to take marbles from the containers and fill them into the chute as fast as the lever emptied it, and see how long he could keep the toy going without letting it empty the chute. Some children had seen the toy before, but none had ever used it in this way. No suggestion was made as to how the marbles should be handled, singly or by handfulls, but the child was urged to "keep it going."

The operation was repeated until 3 trials had been given. If a child could keep the toy going until the pan was full, about twenty-five marbles, he could keep it going indefinitely. Sometimes a child began by using one hand and as he found himself getting behind he brought the other hand into play. Sometimes he used one hand on one trial and the other the next time. Sometimes he changed hands in the course of the same trial. The challenge to speed, it was believed, brought out the child's best effort and revealed something of his native handedness. No attempt was made to standardize the test as a measure of manual dexterity. Record was kept of the hand used, the number of marbles successfully handled, and a comment on care and accuracy of handling, in each trial. Thus the child's record showed which hand he used at first, what he did when he wanted to work faster, and how well he succeeded with each method used.

The results showed a variety of combinations. Approximately one half of both the kindergarten and non-kindergarten groups used the right hand with perhaps a little help from the left. In the non-kindergarten group one fourth used the left hand, one tenth used both hands, and the remainder used the right hand in some trials and both in some, left and both, or left in some trials and right in some.

In the kindergarten group only a tenth used the left hand exclusively as against a fourth of the other group. One fifth used both hands, as against one tenth of the non-kindergarten group, and the remaining fifth used the hands in various combinations, now left, now right, now both.

The examination included a test of eye coördination. A fountain pen was moved before the eyes, and the child was told to follow it with his eyes and not let it get away. Only two or three

children were found who had any difficulty with eye coördination.

Eye dominance was tested with a manoptoscope. The child was shown how to hold it. Then the examiner walked to the other end of the room and told him to look at her. He was told to put it down and record was made of the eye used. Six trials were given in all. The first 2 times no comment was made as to which hand should be used. The third time he was told to use the right hand, the fourth time the left, the fifth time both hands, and the last time no direction was given. Every variety of dominance was found, from consistent right dominance through the different degrees of using now one eye, now the other, to consistent left dominance.

The spontaneous tendency to turn left or right was also made the object of inquiry. It is conceivable that some innate organization in the nervous system might produce such a tendency toward the right or left, which might be associated with right or left dominance, and with ease or difficulty in establishing the proper habits of eye movement in reading. A maze was used in order to examine the child's reaction in turning right or left. The maze as used in this study was not intended to puzzle the child or to test his tendency to look ahead and use foresight. It was an arrangement of pathways which repeatedly offered a choice of equivalent right and left turns. Whichever way the child turned, the path was equally clear ahead. Five such choices were offered in the course through the maze, with the possibility of six if certain turns were made.

Usually there was no question about which way to go, but one boy said to himself, "*Will I take the left turn or the right?*" I'll take the left and then the right." This alternation occurred in a total of 6 children out of 49—two non-kindergarten and four kindergarten. Three children turned always to the right, 4 turned only to the left, and others turned left and right in varying proportions. It was not possible to tell with certainty what prompted the turning, and the test was thought to be somewhat unreliable. Yet its results in many cases do fit into the picture presented by the other tests.

The last test on our list was one devised to examine direction and organization in reaction to symbols. Twenty-five simple drawings of common objects were arranged in 5 lines and columns on a card, and the child *was told to name all of them*. Five such cards were used, with the objects arranged in varying orders and positions, in order to check on reliability or changes in the reaction. If the subject reacted in the same manner to the first 3 cards the test was stopped. If the first 3 reactions were not uniform 5 trials were given. For each trial record was kept of the order of naming.

The lowest level of reaction was marked by total lack of system in naming. The child might begin anywhere and jump to any other picture on the card, or he might use one plan for two rows, then another, and another. Four kindergarten and four non-kindergarten children, approximately one sixth, showed lack of system in the first trial. Of these, 2 kindergarten and 3 non-kindergarten devel-

oped a systematic attack in later trials. For the unsystematic attack which was not improved, no credit was given.

For a systematic reaction one point credit was given if the same system was maintained through three tirals, or through the fourth and fifth in case it was the result of improvement in reaction. The system might be of different kinds: vertical strephosymbolic, lateral strephosymbolic (up and down or back and forth), naming by rows or by columns, or in a spiral movement. Two children from each group showed system without having either sweep or lateral direction. A reaction showing system without other features would be one in which the movement was vertically strephosymbolic, i.e., up one row and down the next, or vice versa.

For lateral direction of movement one point was given. This movement was considered superior to vertical movement in its significance for reading. Lateral movement might be strephosymbolic (back and forth) or it might also show sweep.

Sweep, which received a credit of one point, was the movement from the end of one line back to the beginning of the next, whether in a lateral or vertical direction. Six kindergarten and two non-kindergarten children showed sweep without lateral direction, that is, the movement was vertical but each row was begun at the same end.

Left-to-right movement was credited one point. Lateral movement, even with sweep, would not necessarily be movement in the right direction, though usually this combination did move from left to right.

The combination of lateral movement with sweep, in the left-to-right direction, and beginning at the top of the page, was given one point. This was the optimal reaction in naming from the cards. The maximum score of 5 points was made by 17 kindergarten children out of 27, and 12 non-kindergarten children out of 23. Three kindergarten and two non-kindergarten children fumbled on the early trials but later adopted this system and did not depart from it, thus gaining the full credit.

Improvements of reaction in the course of the 5 trials were of interest. Two kindergarten children began with an unsystematic reaction and later adopted system, one of them even making an optimal performance. Two non-kindergarten children began with a system so poor that it could scarcely be credited, and improved to the optimal reaction. Five cases, four kindergarten and one non-kindergarten, who employed system from the first, but lacked either lateral direction or sweep, were able to add that feature and maintain it, two of them thereby making a maximum score. A total of 6 kindergarten and 3 non-kindergarten children improved their reaction during the course of 5 trials. In no case was there a regression to a lower level during the test.

The naming test was significant in its close relation to the quotient score made by the child on the group tests for reversal tendency. When the quotients were arranged in order it was found that of 17 kindergarten children with quotients from sixty-seven to one hundred, all but one gave an optimal performance in naming. Of 10 non-

kindergarten children with quotients from sixty-four to one hundred, 9 gave an optimal performance. Below these points, 8 out of 10 kindergarten and 10 out of 13 non-kindergarten cases gave an inferior performance.

This test gives different results at different stages in the process of learning to read. At the end of the year it was given to almost 300 children completing first grade work. The vast majority of these children gave an optimal performance, and most of those who did not progress from left to right with sweep, named down each column in turn, beginning at the left. What the results would be if the test were given in September at the same time as the reversal tests, will have to be determined by further research. Perhaps an even closer relation to the quotient score might be revealed, or the dividing point between optimal and imperfect performance in naming might fall at a region higher in the scale of quotients.

The final step of the study for identification of the prospective non-reader was the application of a criterion, that of actual reading achievement. Late in May, when the children were nearing the end of their first year in school, the Gates primary reading tests were given. In the presentation of findings from the clinical study, the quotient score, the intelligence quotient, the Gates reading level expressed in school grade for which the score is average, and the condition of right or left lateral dominance in terms of hand and eye, will be considered. It will be remembered that all children were in the first grade for the first time. Their ages therefore ranged from a few months under six to a few months past six, and was fairly uniform. As for kindergarten experience or lack of it, the two groups will be considered separately.

RESULTS

Table 1 shows combinations found clinically in the kindergarten group of 27 children. Each case is described by a formula of which the first number gives the quotient score on the reversal tests; the second gives the I.Q., and the third indicates the grade for some stage of which the reading score in the Gates tests was an average score. A case called right dominant (or left dominant) is one in which the child uses the right hand and right eye either exclusively or predominantly, and turns right in the maze at least half of the time. Cases designated as right (or left) dominant except maze, are those in which the hand and eye preference agree, but the maze performance does not. Right hand-left eye indicates preference for the hand and eye indicated. Then there are the groups of children who use both hands readily and prefer the right eye, the left eye, or use either eye without preference.

The largest group in table 1 is the group who used either or both hands, and the right eye, seven cases. In this group is one child with a very low quotient, poor intelligence, and a reading performance that was practically nil. The child with the quotient score of 67 came just at the dividing line between optimal naming performance and less than optimal. His performance, however, was a perfect one, his intelligence was good, and he was able at the end of the year to make a reading score that was average for some stage of 1A work —not better than average for the end

of 1A. Of those whose quotient scores were up in the 80's all made reading scores above average for the close of 1A, their relative progress being roughly commensurate with their intelligence.

The 4 cases who used both hands and the left eye show something similar. better progress in reading. This illustrates a relationship which appears repeatedly in the study. Other things being equal, intelligence is the determining factor. But there are so many other things!

Continuing down the list of ambidextrous cases using the left eye, the

TABLE 1

Combinations found clinically in kindergarten group

Comparison of dominance of hand and eye with quotient score RS, intelligence IQ, and reading achievement RL. (Cases are described by a formula giving quotient score/intelligence quotient/reading level.) 27 cases.

Right dominant—6 cases	Ambidextrous—Right eye—7 cases
RS IQ RL	RS IQ RL
55/104/2B	−300/ 73/less than 1B
70/103/Unknown	67/109/1A
100/ 94/1A	87/103/2B
87/108/2B	87/106/2A
100/100/2B	84/126/1A (work deteriorated)
94/111/Excellent	84/124/3B
	86/121/3B
Right dominant except maze—5 cases	
−10/ 94/1B	Ambidextrous—Left eye—4 cases
−70/110/2B	54/ 97/1A
30/115/1A	69/124/2B
88/110/2B	91/104/2B
100/103/2B	97/124/3B
Left dominant except maze—1 case	Ambidextrous—Both eyes—2 cases
85/ 94/1A (L for writing)	−11/101/Unknown
	45/122/3B
Right hand—left eye—2 cases	
65/109/1A	
94/117/3B	

One quotient was below the 60's, the child had just average capacity, and scored just average for 1A work. The next case, quotient 69, may be compared with quotient 67 of the group previously discussed. Both quotients are very similar, the condition of lateral dominance is very similar, but the intelligence varies, and the child with the better mental functioning makes last two again illustrate the principle just pointed out. These two children with a similar degree of reversal tendency, as shown in their quotient scores, differ in intelligence, and the more capable child makes a reading score a grade higher than the other.

Now in this same group, compare the 2 children with similar intelligence, an I.Q. of 124. The child with the quo-

tient score of 69 falls far behind his mate with the quotient of 97. The strength of the tendency to reversal counts heavily in affecting the progress of children whose lateral dominance and intelligence are similar.

Let us now examine the right dominant groups. The first thing we notice is the total absence of I.Q.'s running above 120. Every child with an I.Q. over 120 is in one or another of the ambidextrous groups.

In the right dominant groups, the high quotient scores accompanied by better than average intelligence all make reading scores which are average for some stage of 2B work. Note that here we have no extremely high reading achievement levels. Right dominance, even though free from reversal tendency, is unable to achieve those high levels in the first year of school unless accompanied by unusually efficient mental functioning, or rather, by higher mental age. Two children of low quotient scores, −70 and 55, also made 2B scores, but the one who had to overcome the stronger tendency to reversal had the better intelligence, which may be what enabled him to attain that level.

There are here two children with an I.Q. of 94, slightly below average. One of these, free from the tendency to reversal, did average 1A work. The other, with a minus quotient, made only a 1B score—another demonstration that other things being equal, the stronger the tendency to reversal, the less the achievement in reading.

The first of these two children, the one with the high quotient, may be compared with the one case of left dominance. Both show consistent lateral dominance, one right, the other left. Both have a similar degree of the tendency to reversal, and both have similar intellectual capacity. Both made scores that were average for some stage of 1A reading. Compare them now with an ambidextrous child who uses the left eye. There is one of this sort, with intelligence a little better than theirs, an I.Q., of 97. But the ambidextrous child has been able to overcome a stronger reversal tendency (quotient 54) and still make an average 1A score. This points to ambidexterity as an asset.

There are two children who used the right hand and the left eye. They showed a difference in both reversal tendency and intelligence, the same child having the advantage in both factors. As a result he outdistanced his mate by a grade and a half at the end of the year's work.

The first of these 2 children may be compared with others of similar I.Q. (about 109) in other groups. There is a right dominant child of 108 I.Q. His quotient score is higher and he achieves more in reading than does the child who uses the right hand and the left eye. So it is also with one of the two children in the other right dominant group (right dominant except maze) who have 110 I.Q. The other of these two has a record that contradicts—or was his poor performance on the group tests an accident?

Other comparisons of this kind could be made. They indicate the operation of three factors in the process of learning to read: intelligence, lateral dominance, and reversal tendency.

The significance of intelligence is clear. Other things being equal, the

better the intelligence, the better the reading.

Ambidexterity operates in two directions. We have seen, and we shall see again in the non-kindergarten group, that the child of low mental age shows little preference for either hand and reveals lack of lateral dominance. We have just seen that the very bright child of six to six and one half years, whose mental age is up to seven or eight, is likely to be ambidextrous, but uses one eye consistently. There seems to be a stage between, where many of the children of I.Q. below 120 pause, at least until they are well past the mental age of seven. Of 16 cases of kindergarten trained children whose I.Q. was 100 to 115, nine were right dominant or left dominant, four were ambidextrous and used the right or the left eye, two used the right hand and the left eye, and one, with a strong reversal tendency, was ambidextrous and used either eye without preference. So ambidexterity seems at first to be a mark of immaturity characteristic of the lower mental age. It is then replaced by the acquisiton of skill with one hand or the other, and the very bright child proceeds to acquire, or to continue equal skill in both hands for manual acts, though restricting writing to one hand.

The third of the factors in learning to read, the tendency to reversal, like intelligence, stands out clearly from our analyses. Other things being equal, the child with the low quotient score makes slower progress in reading. This can not be carried too far. A difference of a few points in quotient is no difference at all. But a difference of 20, 30, or 40 points is frequently found to have a significant relation to difference in reading progress, if other factors are fairly equal.

Non-kindergarten children

Children without kindergarten training are grouped in table 2. Again the largest group includes those who are ambidextrous and use the right eye. The right and left dominant groups, which were 44 per cent of the kindergarten cases, are here only 25 per cent.

In the ambidextrous group using the right eye, we find practically the same conditions that were found in the kindergarten group. The 2 lowest quotients were accompanied by intelligence of low average or lower than average grade, and neither child made a score better than average for some stage of 1A reading. Next come 2 children with similar quotients and quite different intelligence. The reading in these two cases is inversely proportional to the I.Q., though it agrees with the very slight difference in quotient score, a difference which however is too slight to account for the difference in reading achievement. We may comment in passing that this child with the I.Q. of 112 was an exception in every classification and a puzzle in many ways We do not know what his home conditions were. The last three in this group, with high quotient scores, and good average intelligence, made reading scores at the second grade level.

The one ambidextrous child who used the left eye had a strong reversal tendency to overcome, but he was a capable little person and did it successfully.

Two children who were ambidex-

trous and used either eye exhibited no deviation from the general rule. With low quotient scores, one of them negative, and with ordinary capacity, they made reading scores that were average for some stage of 1A work.

There are 5 cases that used the right hand and left eye or the left hand and of the two ambidextrous cases using both eyes. Here we have 2 children with negative quotients, no distinct lateral dominance, one with dull normal, the other with average capacity. The dull normal makes a 1B score, the average intelligence makes a low 1A score.

TABLE 2

Combinations found clinically in the non-kindergarten group

Comparison of dominance of hand and eye with quotient score, intelligence, and reading achievement. (Cases are described by a formula giving in order the quotient score/intelligence quotient/reading level.) 23 cases.

Right dominant—2 cases
RS IQ RL
7/ 91/1A
80/ 00/Unknown

Right dominant except maze—1 case
35/ 07/Poor

Left dominant—1 case
100/128/3B (R for writing)

Left dominant except maze—1 case
13/ 00/1A (L for writing)

Right hand—Left eye—4 cases
−030/ 61/1A
63/112/2B
40/113/2A
85/ 00/2B

Left hand—Right eye—1 case
−55/ 85/1B

Ambidextrous—Right eye—7 cases
RS IQ RL
−200/ 88/1A
41/ 06/1A
75/112/1A
78/102/2B (L for writing)
87/103/2B
89/105/2A (L for writing)
05/100/2B

Ambidextrous—Left eye—1 case
−25/113/2A (L for writing)

Ambidextrous—Both eyes—2 cases
−07/ 98/1A
52/ 99/1A

Ambidextrous—no eye test—2 cases
33/ 01/1A
100/ 09/1A

the right eye. The 2 with the lowest quotients also had an I.Q. and mental age far below average, and both were doing failing work in 1A. Though one is marked with a 1A score, it was actually a score that was average for beginning 1A, and was a failure for the end of that grade. The child using the left hand and the right eye makes an interesting comparison with the first

Among the right dominant and the left dominant cases the selection is so limited as to be unsatisfactory. Here is the brightest child in the entire non-kindergarten group. She is left dominant in the tests, but writes with the right hand. Her excellent intelligence and advanced mental age (eight years) presumably enabled her to read with success despite the anomaly. Perhaps

she really belongs in the ambidextrous classification, with the high I.Q.'s of the kindergarten group, since she seems able to do whatever she likes with either hand. There is no other non-kindergarten child to compare with her.

There is a right dominant child, and a left dominant, each of whom has a low average capacity, and each of whom showed a marked tendency to reversal in the low quotient score. One made scores below average for the end of 1A in two of the three reading tests; the other was doing poor work in December, and had left the school before May. With these may be compared other children in the list who have low quotient scores and low average mental functioning. There are two right dominant, one left dominant, one ambidexter using both eyes, and one ambidexter on whom no eye test was made,—all of whom show this particular combination of low quotient score, I.Q. from 91 to 99, and reading score that was average for some stage of 1A work.

The non-kindergarten children show a greater variety in dominance than do the kindergarten group. It has been said that the untrained child is an individualist, and here we have it demonstrated. This variety among non-kindergarten children makes it difficult to make general statements based on so small a group.

We have enough cases to assert that with similar intelligence and quotient scores that are comparable, children will make similar progress in reading. Another significant relationship was found between sum scores on the reversal tests and reading progress for the non-kindergarten children. There was a correlation of .75 between sum scores in September and reading scores in May for the 83 children without kindergarten training who took both tests. For the kindergarten children, the correlation was .54. It was also found that there was a distinctly lower average of both sum scores and quotient scores for the non-kindergarten as compared with the kindergarten trained group.

CONCLUSIONS

From the results of the clinical study of children with varying degrees of reversal tendency, we may conclude:

1. The most potent factors in learning to read are intelligence and the degree of tendency to reverse and confuse symbols.

2. These 2 factors are independent variables.

3. The very bright child is capable of overcoming a strong tendency to reversal and learning to read in spite of it.

4. Other things being equal, the child with the better intelligence makes more rapid progress in reading.

5. Other things being equal, the child with less tendency to reversal makes the better progress in reading.

6. If two children vary in the same direction in both intelligence and reversal tendency, the difference in their progress is increased more than if the variation occurs in one factor only.

7. Consistent right dominance or left dominance, or ambidexterity with use of the right eye or the left eye are the conditions of lateral dominance most favorable to success in reading. This is in agreement with Dearborn.

8. Ambidexterity with use of either

eye, and use of right hand with left eye or vice versa, are less favorable to rapid progress in reading. This again confirms Dearborn.

9. The tendency to reversal is not abnormal or pathological, but occurs in every degree from total absence to severity. This confirms Orton and Illing.

10. Tendency to confuse symbols is characteristic of mental ages below six years, and is usually eliminated in mental ages above seven. This confirms Fildes.

11. Clinical identification of the prospective non-reader depends upon preliminary use of the group tests for reversal, but it is not possible to make a prognosis of reading progress from the test results alone.

12. From the results of the tests for reversal and of individual examination including a general intelligence scale and special tests of lateral dominance and reversal, it is possible to make such prognosis with a fair degree of accuracy.

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Brief Reports

The Dramatic Play of Ten Nursery School Children[1]

ALTHOUGH various investigators have observed that dramatic play makes its appearance during the pre-school years, very little experimental data has been collected. This experiment is an attempt to measure by an observational technique what four-year-old children do in a dramatic play situation.

Diary records were taken on 4 boys and 6 girls enrolled in the University of Minnesota Institute of Child Welfare. Each child was followed for three 20-minute periods on each of 2 days. His speech was recorded verbatim, and as much of the speech and activities of his playmates as could be taken down. In order to observe any continuity of play from period to period it seemed desirable to study each child during all 3 free-play periods on the day he was observed. As the maximum free-play period during the noon hour was 20 minutes, for uniformity an interval of this length was chosen in the morning, noon, and afternoon periods.

The diary records were typed in a special form to facilitate tabulation. Besides the name of the child, date and place of observation (indoors, outdoors, etc.) they contained a complete record of all speech and activity, divided into 2 columns. All sentences of the child observed were typed in the left-hand column, followed by his activities; speech of a playmate was typed in the right-hand column, with the name of the child speaking. The speech and activities were in consecutive order and gave a picture of the total period.

An original and carbon, to be used separately in scoring, were made for each record. All sentences of dramatic play were checked from these records by two observers independently. Dramatic play was defined as any verbalized activity in which the child took an imaginary rôle, played with imaginary materials, or dramatized any performance. No sentence was considered as dramatic play on which there was not agreement between the two observers. Since verbatim conversation had been recorded in preference to activity it was found that the description of unverbalized play was too inadequate to be studied.

The sentences were then listed by the two observers according to their contents. A sentence such as "My baby is going to bed now" was listed as "putting baby to bed." A separate record sheet was made for each child with separate columns for the three play periods. The number of sentences on any topic was recorded, and also the rôle taken and the name of the child making the first suggestion

[1] From the Institute of Child Welfare, The University of Minnesota.

on each topic. All sentences listed under different topics by the 2 observers were re-listed until agreement was reached.

AMOUNT OF DRAMATIC PLAY

Table 1 gives the number of dramatic sentences for each child, the number of topics he suggested, and the group average. It is apparent that there are large individual differences.

TABLE 1
Amount of dramatic play

CHILD		NUMBER OF SENTENCES	NUMBER OF TOPICS	I.Q.
Girls	1	56	11	124
	2	1	1	112
	3	11	3	106
	4	68	7	106
	5	21	5	111
	6	8	1	131
Boys	7	31	6	102
	8	47	8	96
	9	83	17	125
	10	14	6	105
Average...		32.0	6.5	

The range was from one to eighty-three sentences during the 2 hours the child was observed. Five of the children in the group are responsible for 83 per cent of the dramatic play, and at least one of them is present in each play period that lasts more than ten minutes. These totals are from direct observations on each child. Conversation of children playing with the child observed was tabulated but gave only about 1 per cent additional information and so was not used.

A rank difference correlation of .478 ±.16 was obtained between the total number of dramatic sentences on the first and second days. The correlation was .928 between the total number of sentences when the child was observed directly and the total number of suggestions he made when observed directly and indirectly. The correlation between the number of sentences when directly observed and the number of suggestions when directly observed was .932 ±.18. The number of minutes spent in dramatic play as estimated from records on all children, directly or indirectly observed correlated .746 with the number of dramatic sentences recorded by direct observation.

Examination of the data on the frequency of dramatic play at the various periods of the day disclosed a great difference in the value of the periods. In the morning and afternoon periods no dramatic play occurred in 60 and 65 per cent respectively of the observation periods. At noon, however, some dramatic play occurred in 80 per cent of the periods. As the records, when analyzed, showed no consistency of play from period to period, six records of each child during the noon play period would undoubtedly have given better results than the procedure used.

PATTERN OF DRAMATIC PLAY

The main problem of the experiment was to determine what the children did during the dramatic play. From the records, the two observers independently grouped the sentences according to the type of activity involved. Six major groupings were decided upon on an inspectional basis. There was almost perfect agreement between the two observers except on a number of items for which no convenient category could be found.

These were listed as miscellaneous. The number of times any topic was mentioned was obtained by counting each topic only once during any observation period.

Table 2 gives the classification of the types of activity.

Sex differences were inconsistent, although boys seemed more interested in cars, boats and trains than girls. The data on the consistency of rôles and activities of a child from period to period showed no definite trend. The average child in the group participated in 3 of the 6 types of activities listed above, during the six periods when he was observed. In 45 per cent of the dramatic play the child was taking no particular rôle. In 30 per cent of the play the rôle taken was either father, mother or baby, but there was no consistency from one period to the next. Animals, cars, boats and trains, and miscellaneous rôles followed in the order given.

To determine whether there was any pattern to the dramatic play, each instance of dramatic play over 1 minute long was recorded briefly giving (1) location of child and the activity just preceding dramatic play, (2) first dramatic sentence in full, (3) length of time to last dramatic sentence, and (4) activity immediately following last dramatic sentence. Two examples selected from these records are given below:

1. MJ, upstairs in gym. Crawls under bed with PQ. "Go to sleep, huh?" BAH crawls toward them. MJ says, "You can't come in, piggy." BAH: "Pretend I am outside." Play lasts five minutes. Teacher puts trapeze up near children. MJ, BAH begin to swing on it. (Those playing: MJ, PQ, BAH.) Topics of dramatizations: pig, lion.

2. BAH in dollhouse. Telling story about bear. JC says: "Play you be the bear." JS: "I'll bite your head off. I'll bite your stomach off." Play continues until time to go upstairs. (20 min.) Those playing: BAH, JC, JS, SC, PQ. Topics of dramatization: bear, playing house, doctor.

TABLE 2

Types of dramatic play

TYPE OF ACTIVITY	NUMBER OF SENTENCES	PER CENT	NUMBER OF TOPICS	PER CENT
Making, using materials	37	11.21	12	11.88
Family relationships	41	11.42	13	12.87
Animals	55	10.66	12	11.88
Going places	37	11.21	6	5.94
Living conditions	64	19.39	21	20.79
Cars, boats, trains	30	9.09	15	14.85
Miscellaneous	65	19.70	23	22.77

When these records were analyzed, certain definite trends appeared. About 30 per cent of the dramatic incidents began with the statement, "Let's make, I'm making, etc." One third began with the statement, "Let's play," usually followed by the assignment of rôles. The remainder began with the assumption of rôles without definite assignments previously, as in the first record above. Termination of play also occurred in definite ways,

either through distractions, motor activity, or artificially by the end of the observation period, which generally coincided with the end of the free-play period. The distractions that ended dramatic play were such things as a child's crying or new activities being initiated by a teacher. In the rest of the cases, the incident ended when the child began to make or build something that started as dramatic play. His absorption in the actual constructive work ended his imaginative speech about it. This is an interesting illustration of the fact that speech is a substitute for action.

As some dramatic play occurred in 45 per cent of all the observations, there were enough incidents for an analysis of the records to determine whether there was any difference in dramatic play lasting less than the average number of minutes, and the longer play incidents. When dramatic play was begun, it lasted seven minutes on the average. There were 18 incidents lasting 5 minutes, and 7 incidents lasting more than 10 minutes. When these two groups were compared certain definite differences appeared. The median number of children involved in the shorter incidents was 2, and the play centered around one or two topics such as playing house. The median number of children in the longer incidents was 4, with the average 4.9. With 1 exception, all the long incidents involved at least two main topics, with three the average. All centered around playing house, with rôles assigned. Five of the 7 contained a "play within a play," such as being attacked by bears while playing house. The 2 incidents given above illustrate some of the differences.

Although these records seem to indicate a conventionalized type of dramatic play, the number of cases and observations are too small to be anything but suggestive.

REBECCA SHALLIT.

Two New Responses of Infants

IT IS surprising that two responses which are frequent occurrences in the daily life of the young infant should have escaped mention in the literature of child psychology, but I have been unable to find an account of the responses to be described below. These responses I shall call the posture of nursing and the posture of defecation. From the comparative viewpoint, the responses are an interesting parallel to the postures of feeding and defecation in the lower mammals. From the standpoint of the habit-instinct distinction, it seems that these responses must be added to our list of unlearned human responses for the burden of proof is certainly upon one who claims that they are learned prenatally.

1. POSTURE OF NURSING

If the infant is very hungry and is given a nipple, he begins nursing and at the same time the arms flex so that the fists are pulled against the body in the neighborhood of the chin while the legs and toes are extended and raised somewhat. As the infant becomes satiated this posture gradually relaxes, the legs and toes usually relaxing before the arms. If the infant is not very hungry at the beginning of nurs-

ing the leg component may be absent from the start. With still less hunger the posture may be entirely absent, although sucking will occur. (Hunger is here judged from the duration and strength of pre-nursing crying.)

2. POSTURE OF DEFECATION

With each abdominal strain of defecation there occurs a posture of the extremities which is nearly, or perhaps exactly, the same as that described above. With the abdominal contraction the legs and toes are extended and raised and the forearms are held to the upper chest. At the same time the infant may grunt and his face often reddens. In this reaction the leg component is stronger than the arm component in that the leg reaction is more certain to occur. Another difference between the two responses lies in the fact that during defecation the extremities often relax or engage in other activities when abdominal contractions are not in active progress whereas the posture of nursing is held more constantly.

These responses were first observed in a pair of twins[1] which came under my care when they were one month of age. The responses were gradually modified in later months, but these changes cannot be discussed here. Since the initial observations I have observed fifteen newborn infants during one or more periods of feeding and temperature charting. In addition, five prematures, born at seven months' pregnancy, were also observed about one hour per day (at times of bathing, feeding, and temperature charting) for six weeks. In the case of the prematures the responses could not be studied easily during the first four weeks because the babies were almost constantly enclosed in premature jackets, but during some brief opportunities one of the infants was observed in a posture of nursing and four of them in a posture of defecation. When the jackets were removed in the fourth week, the responses were present in all infants and were observed many times during the remaining two weeks of the hospital period. It should be mentioned, however, that the prematures were often completely relaxed and even asleep while they were nursing.

All of the above observations of nursing refer to bottle nursing. No observations of breast nursing have been made, but it seems altogether likely that the same response is given at the breast.

The posture of defecation was often elicited during the taking of rectal temperatures. The thermometer frequently, but not always, caused defecation and the accompanying posture.

The responses are apparently not invariable. One of the prematures at one time flexed his legs during part of an act of defecation and during one nursing period. The same subject held his fists against the sides of his head during another nursing period, although at other times his behavior conformed to the descriptions given above. No other exceptions were observed.

WAYNE DENNIS.

[1] The study of the twins was made possible by the Institute for Research in the Social Sciences at the University of Virginia. For the opportunity to observe the newborn I am indebted to Dr. D. L. Royster, Professor of Pediatrics at the University of Virginia, and to Miss Broyles and Miss Phillips, nurses in charge of the University Nursery.

CORRECTION

May I call attention to an error in the article, *Language Development in Twins*, by Ella J. Day which appeared in the September 1932 issue of CHILD DEVELOPMENT. On page 182 the first of McCarthy's rules for scoring length of responses is quoted as:

> "Contractions of subject and predicate like *it's* were scored as *one* word."

But McCarthy, in *Language Development of the Preschool Child* (University of Minnesota Press, Institute of Child Welfare, Monograph Series No. IV) p. 36, gives the rule as:

> "Contractions of the subject and predicate like *it's, we're, you're,* etc., were scored as *two* words."

The latter was also the procedure followed by Day. Since the McCarthy rules have been adopted by other students of language development, it seems advisable to correct the error which inadvertently crept into the article during the process of publication.

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